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ABSTRACT

This newsletter briefly describes present activities, projects, and publications in the areas of science education, mathematics education, and general science education in Great Britain. Short articles on activities in Ghanna, Hong Kong, Iran, Lebanon, Netherlands and Zambia are included along with descriptions of four other international activities. (BR)

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Science Education Newsletter

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SEN No 23

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ACTIVITIES IN BRITAIN - SCIENCE

1. Processes of Science Curriculum Development - British Council Course

During the last decade in Britain there has been an unprecedented large scale revision of science curricula. The education systems of England and Scotland differ in many important ways and because of these differences the developments in these two parts of the United Kingdom have been on parallel and similar but distinct lines. These attempts to bring about changes in syllabus content and methods of presentation of material have meant that problems concerning the purpose, structure and mechanics of the curriculum have had to be defined. It has also meant that the factors which constrain and those which facilitate change have had to be identified.

The course will provide participants with an opportunity to discuss these problems and factors, and the social and administrative contexts in which the innovations occurred. The broad aims of the course will enable members to acquire

i. a better understanding of the reasons for introducing changes to the curriculum;

ii. a deeper knowledge of the factors and organisations which can affect and effect curriculum change;

iii. a fuller appreciation of the various forms of evaluation and assessment and their use;

iv. a greater ability to devise workable plans for curriculum change;

v. some understanding of the English and Scottish solutions to the problems of curriculum development and innovation.

The course will be in two parts.

Part 1 will last for two weeks and will be held in the College of Education, Dundee.

This will deal with the Scottish education system and curriculum development within it. The Scottish system is in practice, if not in theory, more centralised than that of England and Wales. The total population is under 6 million with some 550 secondary schools in 33 local authority areas (to be reduced to 8 in 1975). Most schools are comprehensive and there is a widespread move towards teaching mixed ability classes in the first two years of secondary education (ages 12 to 14). The majority of children study 'Integrated Science' during these two years.

Part 2 will occupy a further two weeks and will be held in the School of Education at the University of Nottingham.

This part of the course will consist of a study of the diversity of schools within the educational systems of England and Wales in which curriculum innovation has taken place, and an examination of factors constraining or assisting the processes of curriculum change in science. Case studies will be undertaken in schools in the region around Nottingham.

Lecturers to the course will be recruited from the inspectorate, science teachers, university and college staff, national and local authority administrators and advisers, and curriculum development project staff. There will be exhibitions of books, work sheets, pupils' project work and apparatus.

Opportunities will be provided for visits to schools and teachers' centres.

The co-directors of the course will be Mr John A R Hughes, Director of the Scottish Centre for Mathematics, Science and Technical Education Dundee, and Professor James F Eggleston, Head of the Colleges Division of the School of Education at the University of Nottingham.

This course is designed for those involved in the various aspects of the science curriculum development process, namely inspectors of education, teacher trainers, lecturers in colleges and departments of education, senior teachers and curriculum development project staff.

There are vacancies for 30 members. Fee: £275.

This is a residential course. Members will be accommodated in halls of residence. From 26 August - 7 September at Mayfield Hall, Dundee College of Education and from 8 - 21 September at Willoughby Hall, University of Nottingham.

Application forms must be received in London by 1 May 1974.

General Information

Proficiency in English: Members of the course must be proficient in English. They should be able to follow and take part in English conversation conducted at the normal rate. This is essential if they are to derive the maximum benefit from attendance.

Applications: Applications should be made to the Representative, The British Council, or other institution, at the address given below. Applicants for the time being resident in Britain should apply to the Director, Courses Department, The British Council, 3 Hanover Street, London W1R 9HH. Telephone number 01-499 8011.

Travel to and from Britain: Members must make their own travel arrangements to and from the course centre. Return reservations should be made if possible before members leave their own country, as it may be difficult to secure them while in Britain.

Accommodation: No provision is made for accommodation before or after the course. Those requiring such accommodation should book through a travel agent. In the event of real difficulty, the British Council may be able to assist if application is made in writing at least three weeks beforehand. Any such applications must be accompanied by a deposit of £5 for each night's accommodation required. In any event no guarantee can be given that accommodation will be available.

Course fee: The advertised fee includes the cost of board and lodging, lectures and travel during the course. Course Members are required to pay the full fee and no requests for reductions or refunds will be entertained.

Joining instructions: These will be issued by Courses Department through Representatives, giving directions for reaching the course centre including postal address and telephone number of the centre and the latest time of arrival.

Duration of course: Members should assemble at the course centre on the afternoon of the first date shown and will be free to disperse during the morning of the last date, unless anything to the contrary appears in the joining instructions.

2. Schools Council Integrated Science Project - Patterns (See SEN 12.4, 13.4, 14.3. 19.1. 19.2)

The Schools Council Integrated Science Project (SCISP) was set up in 1969. The

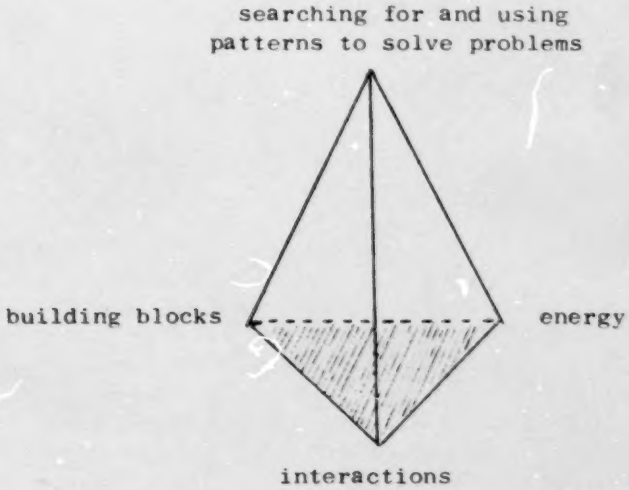
project has developed a scheme for presenting secondary school science as a unified field of study, linked to an examination of double O-level value, and of a standard high enough to provide a proper basis for all existing A-level courses. In 1971 20 schools started using the trials material; they were followed by another 10 in 1972. In 1973, when the first of the project's classroom materials are being published about 120 more schools are to work with Patterns. The entire scheme will appear in four waves between Spring 1973 and Summer 1974.

The method of integrating: pattern-seeking and pattern using

Throughout the three years, pupils continuously search for patterns (important generalisations). These patterns are used to solve problems - which may be found both in and out of the laboratory - and which frequently do not respect traditional subject boundaries.

The emphasis on concept learning, particularly the concepts of building blocks, energy and interactions

The whole content of the work is based on these three useful ideas of science and the project model may be summarised as a tetrahedron.



Novel content, such as earth science and sociology

The new material is not introduced at the expense of a firm basis of biology, chemistry and physics, and enables pupils to move on, without difficulty, to any A-level science course.

The emphasis on the social implications and technological applications of science

Pupils are constantly encouraged to think about the effects of scientific patterns and science-based decisions on themselves and the community.

The teaching approach, which offers flexibility within a structured framework

The method of integrating (pattern-seeking and pattern using) imposes few limitations on content. The sample scheme, which itself contains a proportion of optional material, can be readily adapted or extended to suit the needs of a particular school: the patterns and concepts provide the fixed points.

An attempt to achieve attitude aims

These include willingness, scepticism and concern. Together with the skill aims,

these are used to derive the detailed objectives listed at the start of each section in the teachers' guides.

Built-in assessment

Each section of the teachers' guide includes guidance and sample questions for testing the objectives of the section. The results of such assessment enable teachers to supervise the progress of their pupils and adapt the sample if necessary.

The implication that there is more to science than doing experiments

Experimental work is an important part of Patterns but considerable use is also made of books, visual aids and discussions. Experiments are never performed for their own sake: they are followed by exploration for further patterns and of social and technological implications.

The partnership between pupils and teachers in learning

This is particularly apparent in class discussions.

Double O-level GCE certification

Pupils take Integrated Science-A and Integrated Science-B and may be awarded passes in either or both.

The production of technicians' manuals

These enable technicians to prepare for Patterns lessons with minimal help from the teacher.

The aims of Patterns

Patterns is concerned not only with knowledge and its application but with attitudes and skills, which are partly assessed for the GCE O-level by teachers. For assessment, pupils will demonstrate their degree of competence in:

1. a. recalling and b. understanding those concepts which could enable them to pursue science (courses in physics, chemistry, biology or physical science) to a higher level or as a hobby;

2. a. recalling and b. understanding those patterns which are of importance to the scientist;

3. making critical appraisal of available information (from whatever source) as an aid to the formulation or extraction of patterns;

4. using patterns and making critical appraisal of available information in order to

    a. solve scientific problems and

    b. make reasoned judgements

5. organising and formulating ideas in order to communicate them to others;

6. understanding the significance, including the limitations, of science in relation to technical, social and economic development;

7. accuracy in the reporting of scientific work;

8. designing and performing experiments (in the laboratory and elsewhere) to solve specific problems, and to show perseverance in these and other learning activities.

Pupils should also:

9. be able to work a. individually and b. as a part of a group;

10. a. be sceptical about suggested patterns, yet b. be willing to search for and test for patterns;

11. be concerned for the application of scientific knowledge within the community.

One of the major hopes of the project is that pupils will enjoy science and that an understanding of the aims listed above will help towards that end.

The Sample Scheme

Throughout the three years there is the continuous search for patterns and an emphasis on the social implications of the sciences.

	weeks
Patterns 1: Building blocks	
1. Patterns and problems	1½
Part 1: Building blocks	
2. Galaxies; planets; the Earth	1½
3. Communities and populations	2
4. Looking at organisms	2½
5. Cells and more cells	1
6. Molecules	3½
◁	1
7. Atoms and giant structure	3½
8. The electron, ions and giant structures	3
Patterns 2: Interactions and Buildings blocks	
9. Competition and predation	1½
10. Particle interactions	4
11. Electrical interactions	2½
12. Earth, water and organism interaction	3
13. Motion	1½
◁	1½
14. Classifying building blocks	4
15. Distribution of building blocks	◁ 1

Patterns 3: Energy

Part 2: Energy

		weeks
1.	Transferring energy	5½
2.	Energy and particle interaction	6½
3.	Energy and electricity	4
4.	Sources of energy	3
5.	Using energy efficiently	4½

Patterns 4: Interactions and change

Part 3: Interactions and change

1.	Recognising change	½
	A detailed look at some changes:	
2.	Changes in behaviour	◁ 1½
3.	Changes in acidity	2½
4.	Changes in motion (1)	2
5.	Changes in the Earth	2
6.	Changes in organisms	4½
7.	Changes in motion (2)	3
8.	Changes in atoms	3
9.	Changes in molecules	(2 ((◁ 1
10.	Changes in populations and communities	1
11.	Stability	3
12.	Changes in the environment	2½
13.	Changes in society	½

◁ Optional work (All sections contain some investigations which are optional)

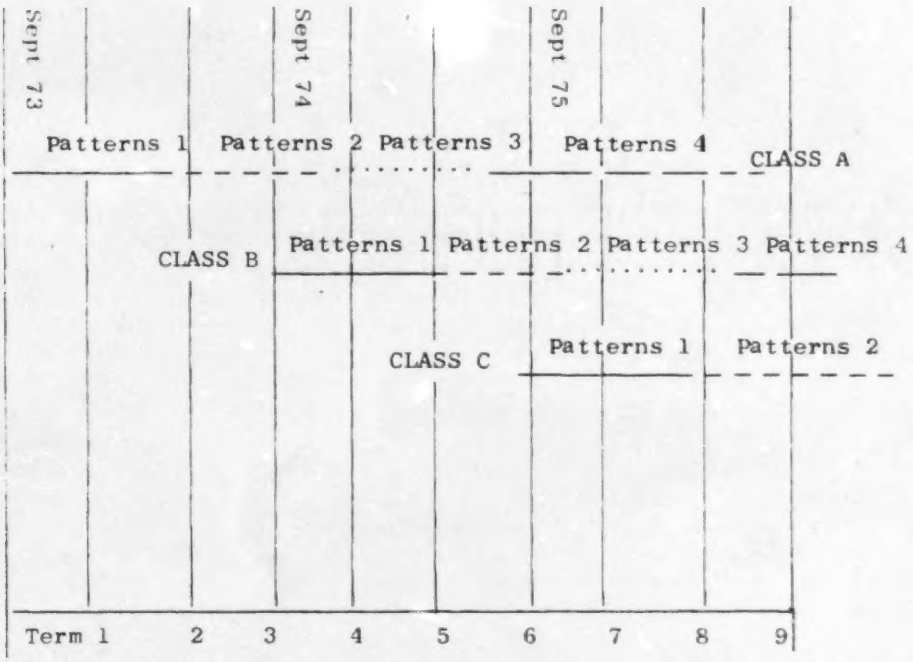
The time allowed for the three parts is: Part 1: 3½ terms; Part 2: 2½ terms; Part 3: 2½ terms.

Four Books for Three Years

It would have been very tidy if the three parts of the Patterns sample scheme building blocks, energy, interactions and change - had each provided exactly one year's work. Unfortunately there is no intrinsic reason why a carefully worked out scheme such as this should fit readily into the administrative divisions of the school year. In fact, as the sample scheme shows, this is not so. However, the structural advantages of producing three books to coincide with the three parts of Patterns were felt to be outweighed by the extra cost to schools of having to buy double sets of Part 1. The problem has been overcome by dividing the first part into Patterns 1: Building Blocks, and Patterns 2: Building Blocks and Interactions. The second and third parts are covered in Patterns 3: Energy, and Patterns 4: Interactions and Change. The chart explains how this works and also shows that

there is always at least one term's gap between one class and the next to enable teachers to take full advantage of the flexibility of Patterns.

In practice, therefore, Patterns 1 will probably be used for 2 terms ; Patterns 2 for 1½ terms; Patterns 3 for 2½ terms and Patterns 4 for 3 terms.



One set of Patterns material may be shared between different classes.

Patterns and Chemistry

Most integrated science projects fail to incorporate sufficient chemical content to enable pupils to continue their studies in chemistry to a higher level. Patterns has paid particular attention to overcoming this problem and, whilst the integrated nature of the scheme makes precise analysis difficult, the sample scheme contains about 29 weeks work which can be labelled chemistry, and which provides an adequate basis for A-level chemistry.

Patterns at O-level

The Associated Examining Board is to conduct the GCE O-level examination on behalf of all GCE Boards: acceptance of the examination for university entrance has been negotiated through the Standing Committee on University Entrance and the Scottish Universities Council on Entrance, and is being negotiated for national certificate courses through the various Standing Committees. The double certification has also been approved by the City and Guilds of London Institute, and the Council for National Academic Awards, the General Nursing Council, and the Armed Forces.

The question papers, which assess achievement in the 'processes of science' and appreciation of the interrelationships between science and technology, and society, are based upon a clearly defined list of scientific concepts and patterns. Since the concepts and patterns may relate to a number of different conventional subject

areas, teachers may have chosen materials other than those used in the Patterns sample scheme. As a result of this, the production of conventional content-based question papers is inappropriate.

Although a single GCE O-level pass may be awarded, pupils must be entered for the whole of the examination which will be devised so that a double pass consists of Integrated Science-A plus Integrated Science-B. A single certificate may also be awarded and will be either a pass in Integrated Science-A or in Integrated Science-B. The nature of 'A' and 'B' will be such that they should provide a crude student profile. Integrated Science-A emphasises the ability to generalise from given data whilst Integrated Science-B emphasises problem-solving ability. Fuller details of the GCE assessment can be obtained from the Associated Examining Board, Wellington House, Station Road, Aldershot, Hampshire.

Patterns and the Curriculum

The many pressures on the curriculum can force pupils sometimes to choose one or two from the three or more science subjects or between science subjects and other subjects, and so lead to premature specialisation. By requiring only one-fifth of the timetable, Patterns relieves some of this pressure without limiting a pupil's A-level options. Patterns will provide an alternative to the Nuffield or other O-level biology, chemistry and physics courses in much the same way as Nuffield Combined Science is an alternative to the first two years of these three. Thus, at the age of 13 there will be the possibility of either separate O-levels, or Patterns or (at CSE level) Nuffield Secondary Science.

The problems for those schools which do not wish to identify pupils for either O-level or CSE courses at the age of 13 years have been recognised. The Patterns materials represent one way of achieving the objectives of the sample scheme. It is anticipated that teachers will adopt alternative arrangements of the materials to meet their needs and to reach the same objectives. Examples of how this has been done are provided in the Teachers' handbook. The common ground and flexibility of both Nuffield Secondary Science and Patterns mean that a third year course (in a secondary school starting at 11 years of age) can be devised in such a way it can lead sensibly to work in either CSE or O-level during the 4th and 5th years.

Teaching Patterns

The Project Team maintains that all pupils in our secondary schools would benefit from a course in science at least to the age of 16, and believes that their understanding will be capable of more effective application if its study is unified and not separated artificially into different uncoordinated disciplines.

Patterns and Teachers

Since few science teachers have been trained in more than two branches of the subject and since the course deals with material from a wide range of work in science, this is a very serious problem, the importance of which should not be minimised.

Often a single teacher enjoys dealing with the entire scheme. In addition, various possibilities for 'team teaching' exist and schools have to adopt their own policy in this matter. (Three case studies are reported in the Teachers' handbook). It would, however, be the antithesis of integration if the material were to be divided into separate areas each taught by a specialist. Thus, in the early stages, two processes must be relied upon. Firstly, and most important, it is essential that there should be extensive cooperation between members of the science department. Secondly, various in-service training courses can make a

contribution. Both of these processes require an immense amount of time, goodwill and effort by the teachers concerned.

Already the existence of integrated science has prompted colleges of education and universities to provide more courses of a broader nature for intending science teachers.

Area coordinators throughout England, Wales and Northern Ireland are in touch with about 150 schools that have already started to use Patterns, or will do so from 1973 in Phase 3 of the Project's programme, which includes an extensive programme of in-service courses. For further information please write to the Phase 3 Coordinator, SCISP, Centre for Science Education, 90 Lillie Road, London SW6, or to the Schools Council Information Officer, 160 Great Portland Street, London W1.

The Cost of Patterns

Wherever possible the Project makes use of existing support material and has produced only essential topic books and no new visual aids. Although many new experiments are introduced, the Project has developed very little new apparatus.

Thus a school with reasonably equipped science laboratories (especially if Nuffield apparatus is used) should incur very little additional capital expenditure on adopting Patterns.

The Publications

Books for Pupils

The Pupils' manuals, Patterns 1, 2, 3 and 4.

1. provide introductory stimulation to new work through extensive use of photographs, newspaper reprints, cartoons, etc;

2. describe the investigations which develop the content of the section;

3. lead pupils towards important patterns and suggest ideas showing their limitations;

4. introduce problems to be solved by the application of these patterns.

Topic books which cover some aspects of the scheme in greater depth are an essential complement to the Pupils' manuals.

Books for Teachers

The Teachers' handbook is the essential introduction to the whole scheme. Each section of the teachers' guides provides:

1. An analysis of the specific objectives (related to the general objectives of the scheme).

2. A flow chart linking investigations to objectives, patterns and other sections.

3. A sample scheme and notes outlining a possible teaching progression with options and alternatives and suggesting suitable support/reference material.

4. Teaching notes giving advice on particular aspects of the investigations and some of the possible difficulties.

5. Guidance on assessing achievement of objectives and sample questions.

Books for Technicians

The four Technicians' manuals give detailed guidance on obtaining, preparing and using the chemicals, apparatus, biological materials, geological specimens, teaching aids, books, etc, needed in the sample scheme.

Publication Spring 1973

Teachers' handbook	0 582 34000 4
Patterns 1: Building blocks	0 582 34009 8
Teachers' guide 1	0 582 34001 2
Technicians' manual 1	0 582 34005 5

Topic books

The importance of patterns	0 582 34013 6
Rocks and minerals	0 582 34015 2
Length and its measurements	0 582 34014 4
Patterns of reproduction, development and growth	0 582 34018 7
Population patterns	0 582 34019 5
Chemical formulae and equations	0 582 34016 0

Publication Summer 1973

Patterns 2: Interactions and building blocks	0 582 34010 1
Teachers' guide 2	0 582 34002 0
Technicians' manual 2	0 582 34006 3

Topic books

The diversity of life	0 582 34017 9
Science and decision making	0 582 34039 X

Publication Autumn 1973

Patterns 3: Energy	0 582 34011 X
Teachers' guide 3	0 582 34003 9
Technicians' manual 3	0 582 34007 1

Topic books

Machines and engines	0 582 34021 7
Sound: its uses and misuses	0 582 34023 3
The electrification of British Rail	0 582 34025 X

Electromagnetic radiation	0 582 34022 5
Weather patterns	0 582 34029 2

Publication Summer 1974

Patterns 4: Interactions and change	0 582 34012 8
Teachers' guide 4	0 582 34004 7
Technicians' manual 4	0 582 34008 X

Topic books

Darwin and evolution	0 582 34028 4
Human behaviour	0 582 34020 9
Friction	0 582 34026 8
Earth patterns	0 582 34033 0
Man and urban environment	0 582 34038 1
Human groups	0 582 34027 6

The publications of this Project are produced by the Longman Group Limited, Pinnacles, Harlow, Essex, England.

3. Nuffield Advanced Physical Science Project (See SEN 12.1, 15.2, 17.1, 20.1)

The Nuffield physical science course is a study of that part of science which lies in the borderline region between physics and chemistry, so that it deals essentially with the structure and properties of matter. It is thus concerned with one of the most central and important parts of science.

Physical science is a new sixth-form subject. It is offered as an intellectually satisfying scientific study in its own right, and not solely as an attempt to 'integrate' sixth-form physics and chemistry.

The course gains authority from having been taught in a large number of schools over 6 years - an exceptionally long period for such an exercise, but one which has demonstrated not only the practicability of the course but also that its introduction can bring a new and wider flexibility to the sixth-form curriculum.

The books now published have been through three drafts in their trial versions. The trials have shown that students respond well to the new approach of physical science. The physical science books appear at a time when there is great interest among teachers and educationists in the integration of the sciences. It may be seen as in part a continuation of the Nuffield Combined Science and the Schools Council Integrated Science Projects, but it does not require the students who take it up to have been through an integrated science course beforehand. The course has great flexibility, which enables schools to adapt to their own special needs the timing, the order of topics, and the emphasis.

The A-level examination in physical science has now been set five times (first in 1968) and more than 3,000 candidates have taken it. 86 schools are currently teaching the subject, and the annual A-level entry is now between 700 and 800. An A-level pass in the subject is accepted by university departments as equivalent to A-level passes in physics and in chemistry. This means that sixth-formers with a physical science qualification find themselves at no disadvantage in applying for university places - rather the reverse has applied, in fact. Both Oxford and Cambridge Universities now include a physical science paper in their entrance and scholarship examinations, and many places and awards have been gained by those offering the subject.

Moreover, students who take physical science instead of the separate physics and chemistry A-levels are then free to take another A-level subject, which means that a greater range of A-level studies is made possible. For instance, physical science can be combined with double mathematics, mathematics and biology, or mathematics or biology with an arts subject.

An A-level pass in physical science similarly serves as an entrance qualification to courses in colleges of technology and further education, service colleges, colleges of education etc.

Students who have taken physical science have done well in comparison with contemporaries who have taken a conventional course; indeed, in some respects they have acclimatized themselves more readily to courses in further and higher education. It has thus become clear that physical science is suitable for those proceeding to further studies in any of the pure sciences, in technology, in medicine, pharmacy, etc, and in less obviously related fields such as the social sciences and law.

Content of the course

The 3 main components of the course are:

The basic course
General and materials options
Project work

The basic course consists of these sections:

1. Forces, motion, and energy
2. The elements of the second short period
3. Kinetic theory and phase equilibria
4. Some important chemical reactions
5. Electricity and atomic structure
6. Chemical equilibrium
7. Intermolecular and interionic forces: structure and properties
8. An introduction to chemical kinetics
9. Covalent bonds and the compounds of carbon
10. Group relationships in the periodic table
11. Elements of the d-block
12. Simple harmonic motion and wave motion
13. Electromagnetic induction and electrical oscillations
14. Electromagnetic radiation.

The general options, of which each candidate is advised to choose 2, are:

G1 An introduction to thermodynamics
G2 Rate processes
G3 Rotational motion
G4 The conduction of electricity
G5 Methods of purification and criteria of purity
G6 Molecular spectra and photochemistry
G7 Further organic chemistry

The materials options, of which each candidate should choose one, are:

M1 Metals
M2 Polymers
M3 Ceramics and glasses

Starting physical science

Teachers are urged to study the Introduction and guide before introducing physical science into a school. This book will help teachers and others to understand the aims and general philosophy of this new and original approach to physical science in the sixth-form. As well as discussing the philosophy and development of the course, there are chapters on teaching the course (especially in the introductory period), on the A-level examination, and on the practical project which all A-level candidates have to carry out. Appendices include a detailed synopsis of the course, specimen examination papers, information on project assessment, and statistics on students who have completed the course. The trials showed that 8 40-minute periods a week should be allowed for the subject, and that initially both a physics teacher and a chemistry teacher should be involved jointly with the class. This presents each teacher with a stimulating challenge that will be as rewarding to him as to his students.

Publications

The Introduction and guide is a valuable companion to the 3 Teachers' guides. Teachers' guides I and II cover the 14 sections of the basic course, and Teachers' guide III contains the general options G1 to G7, and the materials options M1 to M3. Students' workbooks I, II and III correspond to the Teachers' guides. Also for students is the Sourcebook, which is a collection of articles by a variety of authors, some reprinted from magazines and journals and others specially commissioned for the book. As well as providing fuller information on various topics covered in the course, this book also introduces students to the ideas and views of a wide variety of practising scientists and technologists.

Examinations

The A-level examination for the Nuffield physical science course is administered on behalf of all the GCE Boards by the Cambridge Local Examinations Syndicate. Two of the examiners are members of the physical science group, and all key decisions about the form and content of the examination have been ultimately determined by the physical science group and by the teachers from the first groups of trial schools.

The design and marking of the examination are described in chapter 5 of the Introduction and guide, while specimen examination papers are given in Appendix 4 of this book. There is no practical examination; instead, all students carry out a practical project. This is expected to occupy about 10% of course time and carries a similar weight of examination marks. Chapter 4 in the Introduction and guide discusses the project, and project assessment papers are given in Appendix 5, while the Sourcebook contains a large number of abstracts of projects already carried out by physical science candidates.

Costs

It is difficult to state a meaningful figure for the cost of introducing physical science, since so much depends on what apparatus the school already possesses. As a very general guide, however, it may be said that most physical science schools have spent hundreds rather than thousands of pounds initially. If a school has already equipped itself to teach 'modern' physics and chemistry syllabuses, then little or no extra expenditure may be needed. It is expected in fact that in the long run schools will make a substantial saving by the introduction of physical science.

Books for the student

Students' workbook I, 14 082751 X / £2.60. The basic course: Sections 1 to 7

Students' workbook II, 14 082752 8 / £2.20. The basic course: Sections 8 to 14
Students' workbook III, 14 082756 0. The options
Sourcebook *14 082758 7
Nuffield Advanced Science. Book of data, 14 082672 6 / 95p

Books for the teacher

Introduction and guide, 14 082755 2 / £3.20
Teachers' guide I, 14 082753 6 / £5.90. The basic course: Sections 1 to 7
Teachers' guide II, 14 0827544 / £4.90. The basic course: Sections 8 to 14
Teachers' guide III, *14 0827579. The options
* These books will not be available until later in 1973.

Visual aids

The following film loops have been produced for the Nuffield Advanced Science courses. Teachers will find many of these useful in the physical science course.

Conservation of angular momentum *XX1700
Addition to carbon-carbon double bonds XX1641 / £6.30
Applications of paper chromatography XX1636 / £6.30
Applications of the mass spectrometer XX1638 / £6.30
The Born-Habe. cycle XX1633 / £6.30
Forwards or backwards? (1) XX1668 / £5.50
Forwards or backwards? (2) XX1669 / £5.50
Forwards or backwards? (3) XX1670 / £5.50
The hydrolysis of bromoalkanes XX1631 / £6.30
The manufacture of plastic articles XX1634 / £6.30
Organic analysis by the mass spectrometer XX1639 / £6.30
Problems in the use of detergents XX 1635 / £6.30
Rate of reaction XX1632 / £6.30
Solving a standing wave equation for a hydrogen atom XX1667 / £4.25
Testing of plastic film XX1640 / £6.30
Two-way paper chromatography XX1637 / £6.30
Wind-induced oscillations XX1671 / £6.30
X-ray diffraction 1: Production of the X-ray beam XX1663 / £6.30
X-ray diffraction 2: Diffraction of monochromatic X-rays by a single crystal XX1664 / £6.30
X-ray diffraction 3: Diffraction of monochomatic X-rays by a powder sample XX1665 / £6.30
X-ray diffraction 4: Determination of the wavelength of X-rays using a diffraction grating XX1666 / £6.30

* This item will not be available until later in 1973.

The publications of this Project are produced by Penguin Education, Harmondsworth, Middlesex, England.

4. The Nuffield 16-plus Science Project

Early in 1972 it was agreed that action should be taken to provide viable science courses for that proportion of first year sixth-formers who are not following post-O-level courses. Schools Council working paper No 45 estimated that something like a quarter of first year sixth-formers were not following post-O-level courses and that their number is increasing. These pupils have a wide range of ability and interests and are to be found in a variety of different kinds of educational establishment. The outcome of the decision to act was the formation of a small team seconded part-time and led by Mr R Finch, ICI Schools Liaison Officer to work on a curriculum development project.

The project was concerned with non-academic 16 year olds, many of whom were in schools, some in colleges of further education, some in industry with part-time education available and it proposed to produce science based materials for their benefit. The team has interpreted the term 'science' liberally believing that a grasp of scientific attitudes and skills may be acquired in areas of study which could not be described as science in the narrow sense. They envisage only a small content in traditional subject science and have avoided its separation into component disciplines. Attempts have been made to relate the work to future employment opportunities and hobbies and leisure time activity. An element of self-instruction and self-evaluation is being built into the work and the role of the teacher tends increasingly to be that of tutor and adviser with far less formal teaching than in normal courses. Attempts are being made to involve both the school community and the local community in the work. Some of the first materials were tried in Staffordshire under the guidance of the local Science Adviser, Mr K Wild, in Spring 1973. These included units on efficiency and slimming. The project is now moving to its school and teacher centred approach which will develop in the academic year 1973/74. Small groups of teachers under the leadership of Science Advisers will produce materials for the pupils in their own schools based on the working papers within this year, and using the experience of the Staffordshire trials. It is hoped that subsequent exchange of material between schools will contribute to the evaluation and stimulate further work. This may well be an interesting departure in curriculum development.

The initial studies under the guidance of Mr Finch are now complete and the next phase will be carried out during the coming year under the guidance of Mrs Hilda Misselbrook. This is particularly appropriate as her own work for the Nuffield Secondary Science Project is seen as an important introduction to these more advanced studies. A group of area coordinators is being appointed and the team will have the continuing assistance of Sister M Hurst, Denis Fox and Cyril Gilbert. Mr Finch will be returning to ICI but will however remain closely associated with the work of the Project. He was instrumental in laying down the guidelines of the ongoing development. Further information concerning the Project should be addressed to Mrs Hilda Misselbrook at The Centre for Science Education, Chelsea College, Bridges Place, Fulham, London SW6.

5. Independent Learning in Science

In April 1973 a meeting was held at Countesthorpe College, Leicester entitled 'Individual and Small Group Methods in Teaching of Science'. Teachers in schools and universities, lecturers in schools and colleges of education, together with representatives from industry, the inspectorate, publishers, and salesmen with commercial interests took part and in their role as conferees set up the National Organisation 'Independent Learning in Science'. The primary aim of the Organisation is to support and stimulate the development of individual and small group methods in science education in the secondary schools, technical colleges and in other educational institutions where it is felt such methods are applicable. It is felt for example that there will be, and in fact already is, a strong interest in similar developments in polytechnics and universities.

An equally important aim is to enable teachers effectively to cooperate in the production of necessary resources and to facilitate their distribution. Such a cooperative effort has many important implications in terms of the viability and relevance of individualised learning materials produced.

Fundamental to the operation of this unit will be small group activities and 'workshops'. At present a group is working on A-level physics and shortly it is expected that groups will be formed to deal with science for slow learners and O-level chemistry. It is the intention of the Organisation to produce a directory giving comprehensive details of all those interested in this kind of

development, together with a description of the extent of their interest thus enabling like-minded people to get together. Clearly finance will be needed to catalyse such cooperative activities.

The coordinator of this work is Mr E L Green of Countesthorpe College. The group will publish a Newsletter which will be the responsibility of Mr I Newton of Rugby School. The first issue of the ILIS Newsletter is now available and is being given a limited circulation; copies are available on application with a stamped addressed envelope to the coordinator.

It is proposed to set up a National Committee in due course with a first meeting early in Autumn 1973. The Committee will initially be composed of representatives from the workshop and others who have an interest and reason for participating in the Organisation.

A full report of the Easter Conference is now available at 50p to those who did not attend the Conference. The publications and any information regarding 'Independent Learning in Science' can be obtained from E L Green, Countesthorpe College, Winchester Road, Countesthorpe, Leicester LE8 3PR.

6. Higher Education Learning Project - Physics (See SEN 15.12, 18.14, 21.7)

This new project, the Higher Education Learning Project - Physics (HELP(P)) began work in October 1972. The work of many projects within the Nuffield Science Teaching Project is well known, including the school projects at O- and A-level in physics. The differences between school and university teaching however make it impossible to carry out at the higher level the type of programme carried through in school teaching. In particular it would make no sense for a higher education project to attempt to plan and offer a complete course of materials. Teachers in higher education carry a much greater individual responsibility for planning, teaching and examining their own courses. The problems inherent in preparing any innovatory undergraduate course are considerable and the time necessary is very extensive. The project was initiated by a group of teachers who felt that they might develop together new methods and procedures which could improve their physics courses, particularly by changing the ways in which teachers and students relate and interact in teaching and by developing and emphasising the individual responsibility of the learner for his work. These broad aims have been thought through in three specific areas. These are laboratory work, tutorial work and self study.

The aims and objectives of laboratory work have been discussed many times and have been formulated in many different ways but there is little evidence that even commonly accepted aims, such as that of understanding the theoretical work, are being achieved.

The project directors feel that physics tended in the past to have an impersonal aura and they also feel it is essential to counteract this tendency by presenting the subject as a creative activity of persons and by encouraging each student to develop his own appreciation of a capacity to take part in this activity. They regard the small group tutorial as the context within which such aims might be realised.

Recent new work on student learning procedures suggest that this area is an important one.

The universities and colleges at present concerned are Birmingham, Birkbeck, Chelsea, Royal Holloway, Surrey, Sussex and Warwick. The coordinator of the project is Mr J M Ogborn, Centre for Science Education, Chelsea College, Bridges Place, Fulham, London SW6.

(See also 'Physics Education,' Volume 8, No 6, September 1973, page 400)

7. Science 5/13 Project (See SEN 19.3)

This project has recently been granted a one-year extension to September 1974 to enable it to extend its programme of dissemination. Further publications are appearing in stages and recently published titles include: 'Ourselves - Stages 1 and 2' (£1) and 'Like and Unlike - Stages 1 and 2' (£1.10). These are published by and are available from MacDonald Educational, 49/50 Poland Street, London W1A 2LG.

8. Chemistry and Chemical Education - York

The University of York and St John's College of Education, York are presenting a new course for teachers. The three departments in York most intimately concerned with the teaching of Chemistry, the Departments of Chemistry and Education at the University and the Department of Chemistry at St John's College, already have strong mutual ties and, because of their combined experiences, are in a unique position to mount a comprehensive course in which teachers may themselves choose from the available options in Chemistry and Chemical Education a course that most suits them.

The course is divided into two parts and can lead to the University's higher degree of Bachelor of Philosophy. Part I, to be held in the Spring Term, is a 12-week in-service course which is self-contained and designed to enable teachers to study modern aspects of both Chemistry and Chemical Education. Some teachers may wish to take Part II of the course which is principally done in the school over the succeeding 21 months and which is concerned with a short research project. While successful completion of both parts of the course will lead to the BPhil degree of the University, it is emphasised that teachers are welcome to take Part I only and are not asked to guarantee that they will continue to Part II. This may well make it attractive to overseas visitors to the United Kingdom seeking one-term attachments for the purpose of improving their general expertise in the field of Chemical Education.

The course is intended primarily for those who teach an appreciable amount of Chemistry at sixth-form level.

Part I (12 weeks at the University) is divided into three units, each of which offers some options. The units are concerned with chemistry, science curriculum development and relevant modern aspects of education.

a. The chemistry unit is directly relevant to present A-level syllabuses. It develops topics that have found a greater place in recent syllabuses, describes the chemical background and extends the topics in optional areas to allow a study in depth of recent work in selected fields. The topics are firmly rooted in experimental work. Some topics are primarily concerned with the teaching of chemistry as a unified subject, stressing the interrelationships between different areas of chemistry (for example, the teaching of some aspects of organic and inorganic chemistry within a framework of physical chemistry) and between chemistry and other sciences (for example, the impact that physics has had on the elucidation of molecular structure - in particular, the use of modern spectroscopic techniques - and the impact that chemistry itself has had in our understanding of biochemical processes). Time is allowed to enable teachers to develop their own teaching materials and experiments in areas of their choice which they can subsequently test during the course before introducing them into their own school teaching programme.

b. The science curriculum development unit combines an investigation of Chemistry for CSE (Mode III in particular) with a study of recent integrated science projects such as Nuffield Combined Science, Nuffield

Secondary Science and SCISP. These will be studied not only for their intrinsic interest (some teachers may value the opportunity to spend some time familiarising themselves with the material) but as examples of the way in which modern curricula are developed from working papers through trials and implementation to evaluation.

c. The third unit covers aspects of education which are of particular importance to senior science staff and teachers who hope to assume responsibility for a Department in a school. These will include methods of administration, educational aids for science teachers, laboratory safety and methods of assessment.

Much of the teaching and discussion will be in small groups either as seminars (6 - 8 participants) or as tutorials (2 or 3 participants). The laboratories will open extensively so that participants can make the most flexible use of the available time. There will also be opportunities to attend lectures and seminars held in the Departments and more general lectures in the University and at St John's College. Participants will enjoy the facilities of the University and the College and will be members of a Senior Common Room. We hope that there will be the opportunity of living on the University Campus in a college.

Part II of the course (21 months, part-time), which participants may wish to take, leads to the BPhil degree. This will be undertaken at school (the equivalent of 12 weeks' work) and York (6 weeks spread over two summer vacations). The course will consist either of a scientific research project or the preparation of some original material in the field of chemical education. If the latter work is chosen, the fact that much of it will be done at school will enable any teaching materials to be validated in situ. Participants will have as supervisor at least one of the course lecturers who will visit them at school to discuss the progress of the project and ensure that the necessary facilities are arranged, as well as correspond with him. A short thesis will be written on the work and submitted to external and internal examiners for consideration for the award of the higher degree.

Fees: the fee for the short course will be £40 and for the part-time BPhil £100 (inclusive of the short course fee).

Applications: The first course will start in January 1974. Application forms are available from The Registrar, The University of York, Heslington, York YO1 5DD, and completed forms should reach him as soon as possible. Not more than 24 places are available on the course.

9. <u>The Discipline of Chemistry - Its Place in Education</u>

This was the title of a symposium held by the Education Division of the Chemical Society as part of the annual meeting at University College Swansea in March 1973.

A considerable number of prominent chemical education personalities were gathered to discuss this topic and the presentations ranged from an address by Sir Frederick Dainton on the 'Discipline of Chemistry in Education', to University Chemical Education, employment in chemistry and outside and an attempt to identify some future trends. A full list of the addresses is given below.

The Discipline of Chemistry in Education
Sir Frederick Dainton

Justifying the Place of Chemistry in Education
R C Whitfield

Chemistry in the Education of Young Children
E R Wastnedge

Chemistry for the 16-year old School Leaver
M Shayer

Chemistry for O-level
R B Ingle

Chemistry in the Sixth-form
A J Malpas

Discussion on Secondary Chemistry:

i. A chemistry course for 16-year old Leavers
E Gwynne

ii. A Personal View of Chemistry in the Sixth-form
N H Lumb

iii. Science Education - What is left?
J Handy and A H Johnstone

Degree Course Chemistry Teaching - A Review
R Maskill

Tradition or Innovation?
M J Frazer

Chemistry in the Open University
L J Haynes

Education Through Chemistry - A New Approach
N N Greenwood

Chemistry as a Preparation for Employment
L J Bellamy

The Practice of Chemistry
J K Foreman

The Employer's View
A A L Challis

Employment Outside Chemistry - A Practitioner's View
H Burnham

Chemical Education for People who become Employed Outside Chemical Laboratories
J Langrish

Employment Outside Chemistry - An Employer's View
J S Read

Some Future Trends?
M P Berry

The substance of these addresses forms the subject matter of a report on the symposium which has now been published by the Chemical Society Education Division price 75p to Division members and £1.50 to non-members. Copies may be obtained from the Assistant Education Officer, The Chemical Society, Burlington House, London W1V OBN.

10. Association for Science Education - A Report (See SEN 16.14) 'Science for the 13-16 Age Group'.

In 1971 the Association for Science Education published a Policy Statement under the title 'Science and General Education' and followed it in the same year with a Report on 'Science for the Under Thirteens'. After extensive discussion among

the Association's members and at two conferences, a report 'Science for the 13-16 Age Group' has just been produced, which will prove to be a valuable stimulus to discussion on science curriculum developments, and a useful source of reference. The report highlights the necessity to achieve a balance between 'Science for the Inquiring Mind', 'Science in Action' and 'Science for Citizenship'. It goes on to discuss the pressures placed on science teachers by the growth of teacher involvement in assessment procedures, by the need for teachers to operate more efficiently in terms of planning, costing and use of resources and by the need to keep abreast of latest developments on curricula and teaching methodology.

The report examines these essential requirements for efficient science teaching and specifies the need for:

A sufficient number of teachers

A reasonable time allocation

Provision of accommodation

a. Number of laboratories and associated rooms
b. Basic laboratory requirements
c. Basic associated room requirements
d. Preparation/storage rooms
e. Other specialist items
f. Consultation

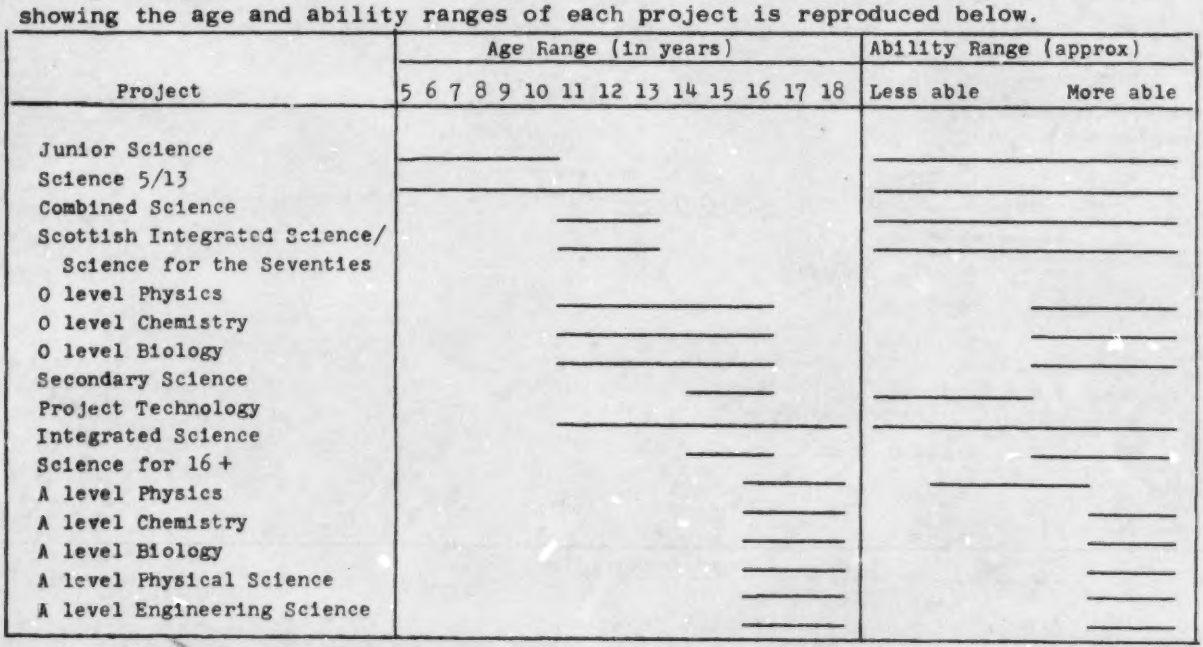
Provision of equipment

Technical and Secretarial Staff

Opportunities for continuing professional development

The report contains a very useful Appendix which includes a brief survey of the major science projects since 1966, a bibliography of books, articles, working papers and examination bulletins.

A diagrammatic summary from the report of the major science projects since 1966 showing the age and ability ranges of each project is reproduced below.



The report, price 30p, is available from the Association for Science Education, College Lane, Hatfield, Herts, England.

11. Early Mathematical Experiences Project

The Nuffield Mathematics Project identifies the need to help pre-school children to develop mathematical concepts and overcome the handicap of those who start in the infant school without relevant experience activities and conversation.

A tree of concepts was mapped out through joint work by the Nuffield Mathematics Project and the Institut des Sciences de L'Education at Geneva. The tree provides a firm basis for the activities of young children but detailed school or class-based work is needed on the early branches to determine how nursery children acquire ideas such as ordering, sorting, matching, comparison and spatial ideas such as neighbourhood and recognition of shapes.

This Project has therefore been established:

1. to identify and classify relevant experiences leading to mathematical ideas. This will involve observing nursery classes and relating their work to the theoretical development of early mathematical concepts;

2. to provide guides for teachers to help them to stimulate the development of mathematical concepts in young children. During the first 15 months work will continue on the concept tree whilst steps are taken to identify good nursery schools and classes. The Project team will maintain contact with these schools and arrange for groups of teachers to meet to discuss their methods and approaches. It is hoped also to involve College of Education staff at this stage.

Teachers' guides will be prepared during this phase and tested during 1975 - 1976 in a number of schools. Audio visual recordings of children at work will be prepared partly for evaluation purposes and partly for dissemination and training courses.

It is intended that teachers' guides will be provided in the form of general guidance and not as a sequence of lessons. Structure will however be indicated by the concept tree and simple ways of recording progress will be suggested.

The guides will include:

1. The tree of concepts and a description of stages of development.

2. An account of experiences relevant to the acquisition of concepts including play, activity, communication with the teacher and exploration of the environment.

3. Case studies of actual activities, records of conversations and reproductions of children's work.

4. Links with experience such as the pre-science of the pre-school education project and the work in language development in the pre-school language project and communication skills in early childhood project.

It is intended to produce a simple Newsletter for circulation to teachers working with the Project etc. A number of conferences will be held later on and it is hoped to make a film of the Project's activities. The Project will be directed by Professor and Mrs G Matthews from the Centre for Science Education, Chelsea College, Bridges Place, London SW6 and will run from 1974 to 1977. The Project will have an evaluater attached to it and he will be Mr A Malpas also of the Centre for Science Education, Chelsea College. The Project will commence in September 1974.

12. Primary School Mathematics: Evaluation Studies (See SEN 20.10, 21.13)

This Project has been granted a two year extension until December 1975. This extension is to enable the Project to undertake:

1. A survey to investigate children's competence in mathematics in wider topic areas than previously attempted and will be extended to some 50 primary schools.

2. An investigation into teachers' attitudes and methods. Teacher interviews and classroom observations will also be carried out.

A revised list of local schemes of work in primary mathematics and teachers groups has been prepared. Copies may be obtained without charge from the Primary Mathematics Project, Reading University School of Education, London Road, Reading RG1 5AQ, England.

13. School Mathematics Project - Work Cards (See SEN 12.10, 18.18)

When the SMP was founded in 1961 its main objective was to devise radically new mathematics courses with accompanying GCE syllabuses and examinations which would reflect more adequately than did the traditional syllabuses the up-to-date nature and usage of mathematics. To achieve this objective in the classroom, textbooks were written to prepare children from the age of 11+ for the new O- and A-level examinations.

By 1967 it had become clear from experience in comprehensive schools that the mathematical content of these texts was suitable for a much wider ability range than had been anticipated but that the presentation ideally needed adaptation. A new series of 8 books, Books A - H, was therefore written for pupils aiming at CSE examinations. In some comprehensive schools the early books of this series were also used by pupils who would eventually be taking GCE examinations and in 1971 it was decided to extend this series to O-level with a new series of books, Books X, Y and Z, to follow on from Book G.

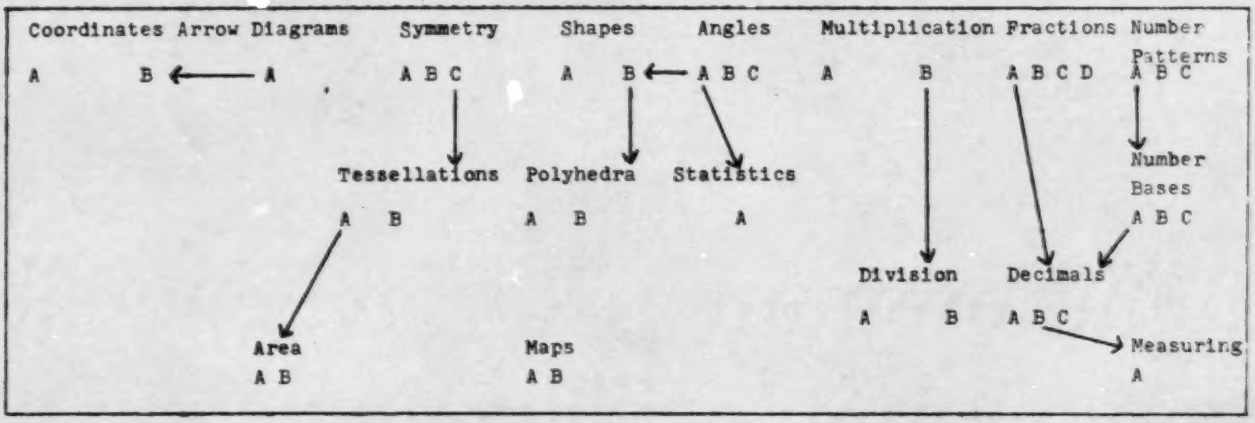
In writing the SMP textbooks the authors found themselves not only introducing a change of content but also a change of method. The books were intended to be read by pupils and required active study and discussion. This trend towards individual and group methods in all aspects of secondary education has gathered momentum during recent years. Such methods have of course been used in primary education for many years. The need for these methods has arisen partly from the difficulty of using traditional chalk-and-talk technique with the mixed-ability classes which have become increasingly common in comprehensive schools. Thus, while Books A - H were intended for about the upper 65% of the ability range and have been used successfully in mixed-ability classes covering this range, their demands on reading ability have been too great for some pupils in the ability range below this. Thus teachers actively involved in the classroom with mixed-ability classes over a wider range needed another presentation of mathematics; the SMP cards are the outcome.

In adapting the material of the A - H series the writers of the SMP cards have had in mind several aims: a. to simplify and clarify the language; b. to take the work in less formidable doses; c. to make the process of checking easier; d. to produce a system which is more flexible than a textbook, which can be adapted more easily to an individual child or to group work, and which can be used for children who have different mathematical backgrounds. A danger with such aims is that they can result in so structured an approach that it loses the interest of pupils and is too complicated to operate in far from ideal teaching conditions. Thus, although the cards have a structure, they contain many opportunities for the teacher to diverge from it. In fact, unlike some

programmed learning systems, the teacher plays an essential role in helping with difficulties and stimulating interest.

At present SMP cards 1 covering the material of SMP books A and B have been published and SMP cards 2 covering books C and D are at present on trial and will follow in 1974. SMP cards 1 complete set consists of 4 packs:

A Main Pack which are arranged in topics as shown in the flow diagram below:



A Supplementary Pack containing more difficult cards for abler children and a set of cards designed to extend and enrich the material in the Main Pack.

A Preliminary Pack which contains cards intended for use when difficulties arise in the use of the Main Pack.

A Stencil Pack containing two types of stencils, for duplicated sheets required for use with the cards, and for revision sheets which are intended for use after the relevant work has been covered.

The cards system is designed with a built-in continuous assessment of a child's progress. It is important that the teacher should be aware of the progress each child is making and that a mechanism for keeping records should be designed which is not too complicated. A set of Teachers' Notes, which accompanies the cards, describes one method of keeping such teachers pupils records.

There are some changes of content from the original books A and B. The main changes of content are:

1. There is an increased amount of numerical work. In preparation for later work on decimals the sections on multiplication and division (of whole numbers) have been included.

2. The development of algebra has been altered. Arrow diagrams have been brought forward. They then link with the work on coordinates and later lead to equations and the mapping notation follows from the arrow diagrams. 'Letters for numbers', Book B, chapter 1, has not been included.

3. Directed numbers are being introduced using the dynamic approach of Book C, chapter 2, and consequently Book B, chapter 10 does not appear.

Most of the written work can be done in lined exercise books or on loose sheets of paper kept in a folder or a file. The size of the card is A5 (148mm x 210mm) and it is helpful if books or folders are slightly larger so that the cards can fit

into them without getting the edges of the cards crumpled. Much of the work requires centimetre squared paper and it is convenient to use books of it. Finely ruled graph paper is not recommended. A large supply of scrap paper and tracing paper is needed. Coloured sticky paper is required for some activities and is useful in tessellations. Squares of plain paper with 10 centimetre sides are needed and coloured card is also useful. Duplicated sheet masters are available in the Stencil Pack for supporting material for a number of the activities including work on regular polygons, symmetry diagrams, maps etc. For a class of 30 - 35 children additional equipment will be required and the Teachers' Notes for Set 1 contains a detailed list of recommended quantities. It also suggests methods of storage of the various items required which make for ease of distribution and utilisation.

SMP cards are published in 4 Packs:

Main Pack, price £5.50. This contains the bulk of the material. Four sets are recommended for classes of 30 - 35 children.

Supplementary Pack, price £1.50. This contains harder work for more able children and also enrichment material for use by all children. Two sets per class are recommended.

Preliminary Pack, price £1.50. This contains work of a semi-remedial nature to help with the arithmetical difficulties which might arise in the Main Pack for less able children. Two sets per class are recommended.

Stencil Pack, about £10. This contains stencils for the duplicated sheets required to accompany the Main Pack and also stencils of revision work. The stencils are designed for Gestetner and Roneo-type machines. One set per school is recommended. Cards are printed in two colours on coloured board and are A5 size and are published by Cambridge University Press.

14. Computers in the Curriculum Project

Recent years have seen a growing interest by teachers, particularly mathematicians, in the possibility of computer studies in schools. This interest has been accelerated by trends towards computer-oriented mathematics and by a growing awareness of the computer as a major social influence in the world. Computers in schools hitherto have largely been used either for teaching programming techniques or for demonstrating the use of the computer for solving mathematical problems. This project will seek to discover how the use of the computer could help assist the teaching of particular topics in a number of subjects other than mathematics. Biology, chemistry, physics, geography and social studies will be among the subjects examined. The work will be concentrated on the fifth and sixth forms of secondary schools and selected sessions will be suitable for all ability ranges.

A number of subject based groups of teachers have been set up throughout the United Kingdom to prepare materials. These groups will be largely composed of subject specialists who will include some computer scientists. In addition to the writing groups, further groups and individual teachers will be involved in the testing of materials.

The materials are likely to fall into one of two categories - a technical aid to teaching or an extension to the pupils' resources for learning - and are likely to be in the form of small teaching packages. These will be structured so as to fit easily into the curriculum for which they are designed and the role of the computer in each will be closely defined, bearing in mind that facilities in schools will vary considerably. The content of the packages will vary but may contain a student's workbook, a teacher's guide, visual support material, the computer programme and documentation, and an outline sheet describing the package.

A parallel project supported entirely by Chelsea College has been running since 1971. This study is in the field of simulation of science experiments by computer, particularly in those areas where science teaching projects see the need for the discovery approach where experimentation is at present not feasible. The project is directed by Mr R E J Lewis at the Centre for Science Education, Chelsea College, University of London, Bridges Place, London SW6 4HR, from whom further information is available. A project paper, No 1, entitled 'Development of Materials and Organisation' is available free from the project.

ACTIVITIES IN BRITAIN - GENERAL

15. The Scottish Centre for Mathematics, Science and Technical Education

The Centre was established in 1971 to act as a focus for curriculum development in the three fields of education named in its title. Originally set up to deal with mathematics and science, its activities have very recently been expanded to include technical education. The term 'technical education' in Scotland includes the subjects of woodwork, metal work, building and engineering drawing, and engineering science. The Centre is housed in the College of Education in Dundee but functions as a quite independent unit.

The direction of the educational policy of the Centre is the concern of the Scottish Central Committee on Science, the Scottish Secondary Mathematics Committee, and the Scottish Central Committee on Technical Education. A Central Committee on Mathematics is to be set up at a later date. The membership of these committees includes teachers, college and university lecturers, as well as representatives from industry, the Scottish Certificate of Education Examination Board (SCEEB), the Scottish Schools Science Equipment Research Centre (SSSERC), local education authorities (LEA) and the Scottish Education Department (SED).

The remit to the Centre is to:

a. collect and disseminate information on curricular developments. The collection is to be on an international scale;

A small, but growing library, of papers, books and learning packages provides reference material for working parties and individual researchers.

b. coordinate the activities of regional groups;

c. issue material for trial in schools; and to collect and process the results of such trials.

The Centre is essentially an organising and coordinating establishment. The staff at present comprises the Director, an Assistant (to deal with Technical Education), an Information Officer, Secretary, typists and a number of auxiliaries. There is provision for the full-time secondment of one science and one mathematics lecturer from Dundee College of Education to the Centre. Most of the preparation of new curricular material, investigation into and revision of current syllabuses is carried out by working parties. It is considered essential that teachers are involved in all aspects of curriculum development and therefore they form the bulk of the membership of these working parties.

The current activities of the Centre include:

15.1 a continuous review of the Certificate of Sixth Year Studies syllabuses in physics and chemistry;

15.2 the organisation of the printing, collating, packing and distribution of the workcards and worksheets for an experimental 'O' grade syllabus in mathematics, known as 'Syllabus B' to distinguish it from the present one. The material is written and edited by a working party of teachers and inspectors. Some 6500 children and 180 teachers in 27 schools in all parts of Scotland are involved in these trials. The formative evaluation of the content, material and teaching method is by means of questionnaires prepared by the working party, and discussions with teachers a. in the schools and b. at area meetings. Evaluation of the development of attitudes to mathematics as a result of this course is the subject of research by the Department of Education of Stirling University.

15.3 involvement in the work of the committee on 'Mathematics for General Education'. This is producing materials suitable for SIII and SIV pupils who are not following certificate courses. Twelve schools are involved in the trials;

15.4 the production of memoranda on various topics. Those already issued are:

Memorandum No	1	Some Notes on the Alternative Mathematics Syllabus for Teachers of Science and Technical Subjects. (Now out of print)
"	" 2	Chemical Nomenclature
"	" 3	Symbols, Formulae and Equations in Chemistry
"	" 4	Chemistry for Certificate of Sixth Year Studies
"	" 5	Symbols and Terminology in Physics
"	" 6	Interpretation of Experimental Data
"	" 7	The New Biology Syllabus - General Notes
"	" 8	Water and Organisms
"	" 9	Biology: Energy and Complexity of Structure
"	" 10	Alternating Current for Certificate of Sixth Year Studies
"	" 11	Anatomy, Physiology and Health (O Grade)

It is planned to continue to issue these memoranda as needed. The following are in various stages of production:

Notes on the Ordinary Grade Biology Syllabus,
Electromagnetism for the Certificate of Sixth Year Studies,
Oscillations and Waves for the Certificate of Sixth Year Studies,
Mechanics for the Certificate of Sixth Year Studies,
Small Scale Methods in Chemistry.

An occasional Bulletin is circulated to schools, inspectors, advisers and Colleges of Education in Scotland as well as to many educational establishments overseas. Bulletins 1 and 2 are now out of print. Bulletin 3 will probably be issued in January 1974.

15.5 The trial of a Certificate of Sixth Year Studies syllabus in biology. This trial is just beginning and a final version of the syllabus is not expected to be generally available until mid-1975. Students following this course will be expected to spend about 40 hours during the year on an individual project and to write a dissertation. The present plan is to produce some 12 or so units of study in 5 categories and then to allow the teacher to choose one unit from each of 4 of the categories to make up the course in his school. This obviously will raise many problems of assessment for the Scottish Certificate of Education Examination Board, which is responsible for the award of the Certificate;

15.6 an investigation into the provision of a suitable science education for the least able children in our secondary schools. This group of children could comprise up to 30% of the pupils in any one year but does not include children in need of special schooling. The work is being undertaken by a working party of teachers, advisers and inspectors with a special interest and it is hoped that they will produce a first report by June 1974.

15.7 a growing correspondence with educationists of all categories from all over the world;

15.8 the planning of visits by overseas science educationists in conjunction with the British Council and the SED.

Curriculum development is seen as not only the planning and implementation of new syllabuses but also the evaluation and improvement of the present curricula. The trend in Scotland as elsewhere is towards more integration of subjects, the development of 'individualised' learning, greater use of internal, school assessment and diagnostic techniques, and continuous development in place of the 'one-off' expensive project.

Further information and copies of memoranda can be obtained from the Director, Scottish Centre for Mathematics, Science and Technical Education, College of Education, Park Place, Dundee DD1 4HP, Scotland.

16. Nuffield Group for Research and Innovation in Higher Education

The Group for Research and Innovation in Higher Education organised by the Nuffield Foundation and composed of Tony Becher, Eric Hewton, Helen Simons and Geoffrey Squires, based at Nuffield Lodge in Regents Park, London NW1, have recently produced the second in their series of Newsletters. This contains brief descriptions of some of the developments in undergraduate teaching which have come to the attention of the team which is currently undertaking a programme of visits to English universities and London colleges. The group states that the main purpose of the Newsletter is to help the flow of ideas among individuals or groups in different institutions who are working along similar lines.

The first of these Newsletters, which is now in short supply, covered items under the general heading of Curriculum, Teaching Methods, Teaching and Learning Resources, Learning Skills, Assessment, the Context of Learning, and Inter-University Projects.

The second Newsletter, issued in June 1973, looks at topics under Course Development, Inter-Disciplinarity, Teaching Methods and Resource Based Learning, Assessment, the Context of Learning and the Open University.

These Newsletters will be of considerable interest to those wishing to extend their knowledge of and contact with new developments in higher education in Britain. The Newsletters are available from the Nuffield Foundation Group for Research and Innovation in Higher Education, Nuffield Lodge, Regents Park, London NW1.

17. SCIREFS

The current state of the British Council SCIREF series is shown below.

7 A list of books on mathematics for O-level students

8 A list of books on mathematics for A-level students

* 9 A list of mathematics books for teachers

10 A list of textbooks on mathematics for primary schools

11 A list of modern British Mathematics Curriculum Project materials

12 A list of modern British Science Curriculum Project materials

14 A list of science books for teachers

* 16 A list of textbooks on science for secondary school students

17 A list of physics books for teachers

* 18 A list of books on physics for secondary school students

20 A list of chemistry books for teachers

* 21 A list of books on chemistry for secondary school students

23 A list of biology books for teachers

* 24 A list of books on biology for secondary school students

Copies may be obtained from your local British Council Representative.

* Annotated.

18. PUBLICATIONS

18.1 Pattern and Variation in Curriculum Development Projects - Schools Council Research Studies - Macmillan, price 95p

Schools Council Research Studies are intended to reflect the wide range of Schools Council research. All the work is related to problems in curriculum development and has practical relevance for the teacher. Subjects include fact finding enquiries; surveys of teacher opinion; case studies of innovations in particular schools; analyses of concepts involved in effective teaching and curriculum improvement; and evaluation of the work of Council projects. These studies will be valuable to all teachers, administrators and others interested in the future of education.

The current report was prepared by members of the Schools Council staff in response to a growing volume of enquiries about the nature and activities of curriculum development projects and how these projects were related to the Schools Council's work. Discussions were held with the directors of 16 well established projects (sponsored by the Schools Council and other organisations) which appear to include most of the significant variations in practice. Answers were sought to five basic questions:

Why have the projects been set up?
What aims can a project have?
What does a project produce?
How do project teams set about their work?
Which people undertake project work?

The information obtained throws considerable light on the theory and practice of curriculum development, and illustrates both the similarities and differences that may be found in projects of this kind. Amongst the projects listed are the Environmental Studies Project, Mathematics for the Majority Project, Nuffield Secondary Science Project, School Mathematics Project, Science 5/13 Project and the Sixth Form Mathematics Curriculum Project. The information provides an interesting commentary and means of comparative study of many facets of curriculum development.

18.2 Assessment of Attainment in Sixth Form Science, Examinations Bulletin No 27, Schools Council, Evans/Methuen Educational, price 65p

This is the most recent report by a working party of the Schools Council Science Committee and concerns itself with the whole spectrum of assessment and attainment in sixth form science. It reviews the information essential to examination design in general, the structure of sixth form science examinations, modes and techniques of examining and proceeds to make a number of recommendations. These recommendations include a proposal for the tripartite structure to include:

The assessment of a common core curriculum in each science subject by a national external authority applied to all candidates in each subject.

The assessment of an alternative syllabus by an external authority.

An element of internal assessment by the teachers.

They suggest that all three of the elements should form part of the published results possibly in the form of a profile and the common element should carry a weight not greater than a half. They recommend also that the

amount of externally prescribed subject matter be reduced and more clearly defined so that the degree to which students and teachers may have real freedom of choice in the curriculum is increased. The work to establish an essential common core curriculum for each science subject is considered important and they wish that it should be started as soon as possible. It suggests that this work should be based on the essential themes, objectives and activities of the curriculum rather than on detailed topics.

It further suggests that the objectives of the assessment should be explicit and should match the objectives of the curriculum, with a move towards the higher mental objectives and away from questions demanding only the ability to remember. In particular they suggest that work should be started to determine those objectives of practical work which would meet with the approval of a majority of the teachers. Assessing attitudes or attributes of personality requires care and they suggest explicit objectives should be stated for this area also.

They recommend also the use of fixed response, free response and structured questions together with the growth of the information-giving type of question and the use of reference books and possibly other aids in examinations. Oral examining is not recommended. Internal assessment by teachers of practical work is preferred to single occasion practical examinations.

Finally they emphasise that assessment should do nothing to inhibit the changing methods of teaching and learning science. It should not inhibit the growth of demand for individual investigation and open-ended discussion of problems in science, including its social aspects. The involvement of teachers in question writing might be increased and experiments in internal assessment by teachers encouraged. They conclude by remarking "We suggest that our recommendations should not be considered in isolation. Science education is a continuous process. It rarely begins or ends in the sixth form. Thought should be given to a continuous policy for science curricula and assessment. In particular we ask those who continue science education to study the changes in teaching and assessment in the sixth form, as reflected in this report so that they may be better informed of the initial attainments of their own students and possibly find something applicable to their own curricula and assessment procedures".

The publication ends with a series of appendices covering current objectives in A-level science examinations, content of sixth form science examinations, examples of new forms of written examinations, examples of new forms of questions, a sample examination specification, an example of experimental internal assessment of practical work, and some forms of moderation of internal assessment in science at present in use at A-level.

18.3 Making Elementary Science Apparatus, M K Bowker and A R D Hunt, - Nelson, price 50p

This publication originally appeared in 1968 and is sub-titled 'A Handbook for Teachers in Tropical Areas'. It begins with a section on equipment and methods of working and constructing various pieces of apparatus. The remainder of the book is divided into sections covering areas commonly found in school science curricula at primary and secondary level. The sections are Biology, Chemistry of Air and Water, Electricity, Magnetism, Heat and Mechanics.

The designs show a considerable range of ingenuity in the use of the sort of materials which are commonly found in the tropical areas. The main

constructional materials are tin cans, locally available wood, bamboo, wire, string, nails, paper etc. For any teachers faced with problems of obtaining sufficient apparatus either for class demonstration or, more importantly, for individual practical work, this book provides much valuable guidance.

18.4 Education 3 - 13

This is a new periodical, the first number of which appeared in April 1973. It is published by William Collins, Sons & Co Ltd, Kirkintilloch Road, Bishopbriggs, Glasgow, in association with the Primary Schools Research and Development Group of the School of Education, University of Birmingham. It will be published twice yearly in April and October. The annual subscription, including postage in the UK and surface mailing overseas, is 90p. Single copy price is 45p. Reduced subscriptions are available to students on application to the publishers. All orders should be sent to William Collins, Sons & Co Ltd at the above address. Correspondence should be addressed to the Editor, Teaching Research Unit, School of Education, University of Birmingham.

The first edition of this new journal contains a number of articles of considerable interest to science and mathematics teachers. The emphasis in Volume 1, No 1, is on Discovery Learning with articles by Colin Richards, Sir Alec Clegg, R F Dearden, Annabel Dixon, Roy Richards and others. For scientists Roger Harris writes an interesting article on Locusts, Gerbils and Barley: 'Keeping Living Things in Primary Schools'. In the Reviews Section the series 'Let's Think About Mathematics: Let's Find Out About Mathematics' by Leonard Seeley is given an extensive and authoritative review by Gordon Pemberton.

This new journal is an interesting and valuable addition to the current literature available on development in education in this age range.

18.5 'Studies in Science Education'

This is a new periodical to be published by the Centre for Studies in Science Education in the University of Leeds. It will be edited by Professor David Layton and will be an annual review of research and critical issues in science education. The first volume of this new journal will be published in January 1974. The Editorial Advisory Board is:

Professor Peter Fensham, Faculty of Education, Monash University, Australia,

Dr Gareth Howell, Head, Science Education Section, The British Council, London,

Professor F R Jevons, Department of Liberal Studies in Science, University of Manchester,

Professor Kevin Keohane, Director, Centre for Science Education, Chelsea College, London,

Dr Gerhard Schaefer, Abteilung Biologie, Institut fur die Padagogik der Naturwissenshaften, Kiel, Germany.

Contributors to the first volume will include articles by:

Kenneth Lovell - 'Intellectual Growth and Understanding in Science'

Alex Johnstone - 'Evaluation of Chemistry Syllabuses in Scotland'.

Michael F D Young - 'School Science: A Sociological Perspective - Some Problems and Possibilities'.

Peter Fensham - 'Implications of Ausubel's Theories and Ideas in Science Teaching'.

It will also include essay reviews by John Nisbet - 'Fifty Years of Research in Science Education'. Research Information will contain two items, one by Dick West on the ASE Research Committee and one by Gerhard Schaefer on the Science Education Research Programme at Kiel, together with a list of theses recently completed and in progress.

Annual subscription in the United Kingdom and elsewhere overseas will be £2.00; in the USA $6.50 including postage. Cheques etc should be made payable to The University of Leeds and crossed. Remittances from overseas should be in sterling. Subscriptions, orders and enquiries should be addressed to: The Business Manager, Studies in Science Education, Centre for Studies in Science Education, The University, Leeds LS2 9JT, England.

18.6 University Chemistry Teaching - Proceedings of the International Conference on University Chemistry Teaching. Edited by D McCormick and P J Towse. Published by the East African Literature Bureau.

An International Conference on University Chemistry Teaching was held at the University of Nairobi, Kenya, from 14 - 18 December 1971. It was attended by mainly African university staff with invited speakers from the United Kingdom, the United States and UNESCO.

The opening address was given by Professor F R Jevons of the Department of Liberal Studies in Science at the University of Manchester on the subject of 'The Teaching of Science'. This set the background for discussions on the objectives of teaching chemistry in developing countries in which the key speaker was Dr D Odhiambo of the University of Nairobi. A group of international consultants then looked at some perspectives in university chemistry teaching. This was followed by a series of presentations dealing with particular aspects of chemistry teaching, ranging from theoretical physical chemistry to laboratory techniques.. The remaining two sections of the publication cover a group of papers entitled 'On Teaching and Learning' and a group of miscellaneous items including a description of the work of the Open University in the United Kingdom and proposals for the setting up of a new chemical journal to be entitled 'Chemistry in Africa'.

In recent years much general discussion has taken place on the function of university education in developing countries. Rarely has a group of university educators got together and discussed their problems in such depth and with such clarity as was revealed in these papers. Although the basic theme centres around chemistry many of the points discussed are equally relevant to the study of the other sciences in universities in developing countries and indeed to subjects other than science. The contents of this publication are a valuable addition to the contemporary literature on these problems and deserve close study.

18.7 Bulletin of Environmental Education - (BEE)

BEE is a monthly bulletin for school teachers produced by the Town and Country Planning Association (TCPA). The TCPA is a nationwide, all party voluntary association and registered charity. Its education unit and BEE were launched in 1971 with grants from the Joseph Rowntree Memorial Trust and the Elmgrant Trust. BEE's emphasis is on the urban environment but other aspects of environmental teaching are also covered. BEE seeks to help teachers use the widespread interest among pupils and students in environmental issues.

BEE offers readers:

guidance on available sources and resources - lists of books, films, slides, filmstrips, study kits etc, and 'do-it-yourself' resource kits;

teaching ideas and methods, lesson suggestions, games and simulations;

authoritative articles on the methodology of environmental teaching in several subject areas - geography, history, English, art biology etc;

reprints of articles from the newspapers and the technical press which have teaching potential or which bridge the gap between the environmental and teaching professions;

material which can be used in class or adapted for this purpose.

BEE was first published in May 1971. Since then there have been special issues on:

Town Trails - how to make and use them

Games and Simulations and the environment

The global 'Environment Crisis'

Shopping and Supermarkets

Transport Alternatives

Examinations

Education Out of School

BEE has also published DELTA (the Council for Environmental Education's Directory of Environmental Literature and Teaching Aids) in its entirety. Individual articles, many by serving teachers, have covered a host of other themes - the Inner City, Housing, New Towns, Pollution, Motorways, Environmental Politics, Parks, Community Work Schemes, etc.

The editors of BEE, Colin Ward and Anthony Fyson, worked in architecture and planning respectively before training as teachers of general studies and geography. They both came straight from the classroom to form the TCPA Education Unit.

They are co-authors of Streetwork: the exploding school to be published by Routledge and Kegan Paul during 1973. Mr Ward has also written two books in the Penguin Connexions series and edited a forthcoming Architectural Press book on Vandalism.

Annual subscription £2.00. Extra copies £1.50. Special BINDERS 25p. Education Membership of TCPA £5.00.

NOTE: Those eligible for Education Membership include all persons employed at educational or youth establishments. Education Membership may also be taken out in the name of any such establishment or organisation. Education Members receive BEE and the Association's Journal Town and Country Planning. For further information contact Education Unit, Town and Country Planning Association, 17 Carlton House Terrace, London SW1Y 5AS.

18.8 School Book Guide: Secondary Geography, D A Viney, Education Book Distributors Ltd, price £3.00

This Book Guide is intended as a basic source of reference, which attempts to give details of every book available in the field of geography at secondary level. The aim of the book is to facilitate the business of searching for a book by presenting an unbiased list of books in a manageable and standardised form. The entries are divided into the sort of subject categories which a teacher would have in mind when looking for a new book, but additionally there is an index of entries by author and title, making cross referencing possible.

Information on each book is provided by a set of standardised symbols and by a brief commentary and in addition to the usual information it includes:

Interest Age/Reading Ability

Short description of book

Examination for which book is suitable

Whether or not photos/maps/illustrations included.

This book is clearly of inestimable value to the school librarian and teacher of geography both in Britain and in countries overseas.

18.9 School Book Guide: Secondary Biology, D A Viney, Education Book Distributors Ltd, price £3.00

This is the second School Book Guide, which follows 'Secondary Geography' in the series. The same format is adhered to, and school librarians and teachers of biology both in Britain and overseas countries will find this book to be of great value.

18.10 Biological References, M Sheila Gosden, The Centre for Studies in Science Education, The University of Leeds, price 45p (42p for 10 or more copies).

This is a booklet (63 pages) containing references for biology teachers and lecturers of relevant articles and notes which have appeared in the School Science Review and the Journal of Biological Education during the period 1960-1972.

Hard pressed teachers who have attempted to find relevant articles quickly will know the frustration which this can lead to, and will readily welcome this extremely useful booklet.

The titles of all articles and notes in both journals have been classified under a series of headings, chosen because they seem to be the most frequently encountered. They include topics such as ecology, genetics, post-school biology, respiration, curriculum development and assessment, visual aids, and overseas science education. References are arranged in chronological order within each section, and so placed on the page that a wide margin is available for brief notes. It is intended to up-date the index from time to time by producing supplementary booklets. This booklet will be of considerable value to biology teachers, lecturers and librarians.

18.11 Anatomy, Physiology and Health (Ordinary Grade) Memorandum No 11, The Scottish Centre for Mathematics, Science and Technical Education, 1973, price 25p

The memorandum was prepared for the Scottish Certificate of Education

Examination Board in an attempt to suggest possible teaching guidelines on the basis of the existing syllabus. It does not suggest alterations to the syllabus but it is hoped that all concerned will be stimulated to make constructive comments and suggestions to the Scottish Centre for Mathematics, Science and Technical Education.

The syllabus is divided into two main sections:

> Anatomy and Physiology: Containing topics on The Cell, Skeletal (and locomotor) systems, Nervous System, Nutrition and Digestive System, Transport Systems, Respiratory System, Excretory/Regulatory Systems, Reproductive System.
>
> Health: Containing topics on Biological Responses, Personal Health, Environment and Health, Health and the Nation, World Health and Historical Perspective.

The memorandum suggests that as the science course in the first two years in many Scottish schools is a general course based on the Integrated Science Course (ISC), some parts of this ISC could be exploited as a source of background knowledge in preparing pupils for the 'O' grade A P and H examination. But it warns that the ISC is a course of 'patterns' which stresses concepts rather than hard facts. It suggests a detailed table of cross references between the ISC and the A P and H syllabus.

There is a useful section listing appropriate publications and audio-visual aids, including a list of pupils' textbooks, background readers and pupils' reference books, teachers' reference books, films, filmstrips and filmloops.

Perhaps the most valuable part of the memorandum is that listing suggestions for practical work against each topic in the syllabus. These suggestions show how each topic can be treated experimentally and cross references are given to sources of information. A list of equipment and materials required to carry out the practical work follows, clearly indicating those items required for pupil activities and those for demonstration and an indication is given of those items which are on the SSSERC Basic Biology Equipment and Biology Lists.

The memorandum ends with suggested flow diagrams showing possible lines of approach to teaching the subject.

18.12 Fifteen Starters for the Secondary Classroom, Association of Teachers of Mathematics, price 25p

At the 1973 Association of Teachers of Mathematics Conference in Reading some people came together to work on a number of situations which were suggested by some of the group. This pamphlet is the product of the work of this group. As its name suggests, it contains fifteen ideas as starting points for mathematical activity in the secondary school: these include skeletons, geometrical figures, closed curves, noughts and crosses, parallels and perpendiculars and stick crossing amongst others and show how ideas in these fields may be developed with young children.

The publications of the Association of Teachers of Mathematics are available from the Association at Market Street Chambers, Nelson, Lancashire, BBn 7LN, England; prices quoted include postage in the United Kingdom.

19. SCIENCE EDUCATION ABSTRACTS

19.1 Nuffield A-level Biology: Attitudes to Science, C Selmes, Journal of Biological Education, 1973/74, 43-47

Following a recent series of articles on students' attitudes towards science, the Journal of Biological Education presents a report on a comparison of the performance on a scale of attitudes towards science of a group of sixth formers following the Nuffield A-level course with a group following other A-level biology courses. The attitude scales were completed in their schools by the sixth formers during late June and early July 1970, immediately after the completion of the A-level examination. The article describes the construction of an attitude scale towards science using a Likert type scale. Three types of items form the basis of the original questionnaire. Items which:

a. refer to scientists and how they behave both in their work and as people;

b. refer to science in general terms with a reference to the investigatory nature of science;

c. state an opinion about science as a method of investigation.

Items were identified as favourable or unfavourable for scoring purposes and the respondent is allowed to use five categories of agreement or disagreement ranging from strongly agreeing, agree, undecided, disagree, to strongly disagree. The author argues that if the objectives and abilities of Nuffield A-level biology courses are being attained in schools by the teachers, one would expect different attitudes to science among these sixth formers when compared with sixth formers who are following courses where such objectives and abilities do not form an important part of their work. This particular study showed that girls (as a group) had significantly higher scores than boys; this is an unusual result as it is the first study which has shown this difference. Reasons for this difference are advanced. The study found no significant differences between the mean scores of Nuffield and non-Nuffield biology students on the attitude scale used. Comparison with earlier reports by Kelly on the performance of Nuffield A-level biology trials are included at this point. The reasons for this lack of differentiation are advanced with the author favouring the alternative suggestion that neither type of biology course is affecting the attitude to science of their students. He suggests that attitudes to science are developed before entry to the sixth form and that they may not be altered to a noticeable extent by differences in courses at this level.

The Journal of Biological Education is published by the Institute of Biology six times a year. Subscription rates abroad: £4.00 plus £0.45 postage. Subscriptions from USA, Canada and S America: $10.80 plus $1.20. Subscription orders should be placed with the Institute of Biology, 41 Queen's Gate, London SW7 5HU.

19.2 The Nuffield Physical Science Course; London Educational Review, Volume 2, No 3, Autumn 1973, page 62, by J E Spice

Dr Spice discusses the Nuffield Physical Science course (see SEN 23.3) describing its genesis, the curricular advantages it provides for students, its characteristics and finally its present and future place within the curriculum.

The Nuffield Physical Science course represents a new advance in the integration of science studies theme which has become so strong at lower levels in the secondary school. The recent publication of the detailed materials of the Nuffield Physical Science course has allowed people to make a more detailed study of the activities of this project. There are many clear advantages to the use of physical science as an A-level study in place of physics and chemistry. For example it means that combinations of mathematics, physical sciences and biological sciences can be provided thus producing a much better balance of science studies either for the potential scientist or for the 18 year old school leaver. This is but one of the advantages claimed for the project in this article.

London Educational Review is the journal of the University of London Institute of Education; orders and subscriptions should be sent to King, Thorne & Stace Limited, London Educational Review Department, King Thorne House, School Road, Hove, BN3 5JE, Sussex. Overseas subscriptions: £175 per annum; single copy 65p; all rates include postage.

19.3 Testing and Evaluation - Australian Science Teachers Journal No 58 June 1973, Vol 19, No 2

The current edition of the Australian Science Teachers Journal contains a series of articles on testing and evaluation in science courses. Together they constitute one of the most comprehensive recent sets of articles in this field. The principal articles are as follows:

Roles for Evaluation in Science Courses
L D Mackay

Preparative Evaluation of Secondary School Chemistry Students
P L Gardner

Evaluation Reinterpreted
D Cohen

Curriculum Evaluation - Part I: Hard or Soft?
Part II: An Illustration Using ASEP Trial Data
B J Fraser

Multichoice Test Marking Scheme - EVAL
D Woodrow

Criterion-Referenced Testing in a School Chemistry Course
I M Ling

The subject of evaluation is probably the most hotly debated of all aspects of curriculum activities at the present time. Mackay looks at three different types of evaluation: preparative, formative and summative evaluation. Gardner looks at preparative evaluation in some depth and the context of chemistry teaching and Cohen looks at more general questions such as What to Evaluate and How to Evaluate in the context of education in science in Australia at the present time. Some illustrations from the Australian scene of current developments are given by Fraser, Woodrow and Ling.

The Australian Science Teachers Journal is published by the Australian Science Teachers Association and the annual subscription is $7 (Australian) per volume of 4 issues, plus 50 cents postage for overseas subscribers. The Advertising and Business Manager is Mr N M Niemann, 66 Illawarra Road, Hawthorn, Victoria 3122, Australia.

19.4 The Design and Evaluation of Science Courses at the Open University, A R Kaye, Instructional Science, Volume 2, No 2, August 1973

This is a descriptive paper which attempts to give a brief overview of the nature of the course materials used in science teaching at the Open University and the procedures adopted for assessment and evaluation. The first two sections contain background information on the Open University and the teaching programme of the science faculty respectively. The final section gives a short summary of course production methods. It is obviously not possible in a paper of this size to cover in detail all aspects of course design and evaluation and many of the areas touched upon deserve more detailed treatment. However the individual will gain a fairly comprehensive insight into the design of science teaching materials and multi-media presentation in a 'Teaching at a Distance' framework.

Instructional Science is published quarterly by Elsevier Scientific Publishing Company, PO Box 211, Amsterdam, The Netherlands; subscription rates: individuals who require the journal for their own personal use Dfl 45.00 including postage; libraries, research institutions and others Dfl 88.00 including postage. Subscription orders should be sent to the office of the publisher. Subscribers in the USA and Canada receive their copies by air mail; additional charges for air mail to other countries are available on request.

19.5 The Planning and Teaching of Science According to National Needs: Professor Thomas R Odhiambo. Impact of Science on Society. Vol XXIII, No 2, April/June 1973, page 95

This article examines the growing viewpoint in many countries in Africa over the last few years that science and technology can provide the vital arsenal for solving development problems. The capability and potential of Africa in the fields of scientific discovery, technological innovation and practical application are examined. The author draws attention to the technological achievements of past African civilizations and the work of scientific research in the colonial era, but concludes that the former could not provide the base and perspective necessary now for the renaissance of African science and the latter concentrated only on specific and limited fields of research.

The author goes on to argue that the all-embracing monistic world view of the Bantu and Nilotic peoples has not provided the right environment for the analytical scientific method to flourish in Black Africa. A decisive factor in whether or not the exact sciences will flourish in Africa must therefore be whether or not a socio-philosophical environment can be developed to stimulate such an analytical method. The author briefly examines the adoption of an appropriate system now from technically developed countries as one solution to the problem, while adaptation of a system to specific national needs is considered as another solution. Considerations in drawing up a science strategy are listed as follows:

Urgent projects in need of solution

Generous budgetary provisions for science

Adequate rewards for scientists

Management skills in the organisation of the scientific effort and its utilisation

Science-oriented education

Establishment of a resident scientific community

The author argues that scientists are motivated when working on urgent problems. Once these problems have been identified, African scientists need not bother with controversies such as fundamental versus applied research, they can instead look forward to the time when they will be establishing new and relevant technologies. In order to provide the correct environment in which to innovate, where there are only 7 science-oriented graduates per 100,000 of population, a special effort and clearly defined policy must be enunciated.

The article concludes with a consideration of the need to identify priorities by formulating an Urgent Priority Index (UPI).

'Impact of Science on Society' is published quarterly by UNESCO and reports on science as a major force for social change; describes and predicts the consequences of scientific developments for the individual, for nations and for mankind as a whole. Written for the educated layman and the scientist by outstanding natural scientists, social scientists and other specialists, each number of Impact is entirely devoted to a subject of significant interest and importance for the citizen of today. Planned for 1973 are issues on: The biological bases of human behaviour; Science and Black Africa; Technology and art; Science and the university in a changing world.

Further information can be obtained from 'Impact of Science on Society', UNESCO, 7 Place de Fontenoy, 75700 Paris, France.

Annual subscription: £1.20; single issues 40p.

19.6 Maths for the Majority Continuation Project: A Complex Mixture of Awareness and Ignorance, P Kaner, Newsmaths 6 and 7, Summer 1973, page 4.

In this article Peter Kaner analyses the current state of mathematics education in secondary schools and faces the challenge of a mathematics education suitable for the whole range of children's ability. He argues that mathematics education cannot be separated from its function. Currently we would go far beyond the idea of mathematics as arithmetic for shop-keepers et al. However it would be wrong to underestimate the power that lies in the simple knowledge of arithmetic. The change from arithmetic to mathematics for all is relatively new both in the United Kingdom and in Europe. Mr Kaner advances some interesting theories in the way in which geometry and algebra in particular acquired a large proportion of significance in mathematics courses. The current swing between traditional and modern mathematics reflects a clash of interest between engineers, physicists and mathematicians themselves for the control of courses. Current weaknesses in mathematical attainment by children in the average intelligence range is not likely to be improved by the application of traditional concepts of mathematics in education. The Mathematics for the Majority project on the other hand attempted to summarise good mathematics teaching practices and to publish them by collecting them together in teachers' guides. However, Mr Kaner argues that the guides revealed an internal conflict in that they recommended any method which adapts material to the pupils, yet the whole approach was already structured by dividing mathematics into sections algebra, number shape (geometry) etc. The problem before this project and before the Continuation project was that at the end of a four or five year course in a secondary school 40-50% of the pupils do not qualify in mathematics and this fact renders the course itself relatively worthless. Mr Kaner discusses a couple of the more common misconceptions regarding education through mathematics, namely:

1. That mathematics trains the mind.

2. That there is a fundamental body of knowledge of mathematics everyone must know to be able to survive.

The justifications for both of these are falacious in Mr Kaner's thinking. He argues that one can start by thinking about cases where mathematics education has had indupitably valuable rewards. We could then identify which part of the activity carried rewards. He offers some suggestions as to the type of rewards which might be considered and goes on to suggest various areas of child experience and development in which mathematics has something to offer. He suggests that it is in fact not desirable to separate objectives of teaching mathematics from those general education objectives which form the basis and justification for the existence of the school. In all activity in the school the major aim is intellectual growth on the part of the pupil. We know from experience that mathematics education can and should contribute to this. If it is failing in this task then its value comes very much into question. A list of the aims identified during discussions with teachers of the mathematics and majority continuation project is included in the article and some of the items will no doubt surprise the more purist mathematicians.

Newsmaths is the journal of the Maths for the Majority Continuation Project and is published three times a year from 3 The Cloisters, Cathedral Close, Exeter EX1 1HS; single copies 20p, subscription 20p.

19.7 Mathematics and Science in the Secondary School, A J Malpas, Education in Science, April 1973, No 52, p.27

This paper seeks to answer three questions:

1. What mathematical skills are required in the new secondary school science courses?

2. To what extent do courses in modern mathematics provide for the development of these skills?

3. In what ways can the work of Science and Mathematics Departments in schools be more closely linked to promote effective learning of these skills?

There has been much debate recently on questions of identification of the mathematical concepts and skills required for science study. This problem has been highlighted by the changes in the mathematical courses in primary and secondary schools, involving a greater proportion of 'modern' mathematics, and a reduction in the time allocated in the development of more traditional mathematical skills.

The article attempts to survey the mathematical requirements of modern science courses and looks in particular at ratio, proportion, linear relation and related concepts in mathematics for Nuffield Science as treated in SMP mathematics; measurements and statistical treatment of data, geometry and trigonometry. As an example of the type of coverage given, the tables on measurements and statistical treatment of data and geometry and trigonometry are reproduced below.

The author argues in favour of closer cooperation between science and mathematics teachers and welcomes the new and developing pattern of joint appointments of head of mathematics and science departments in schools.

TABLE 1 MEASUREMENTS AND THE STATISTICAL TREATMENT OF DATA

Year of Secondary School Course	Year 1 (11-12 years)	Year 2 (12-13 years)	Year 3 (13-14 years)	Year 4 (14-15 years)	Year 5 (15-16 years)
Nuffield Biology	DS DS DS Av M	DS DS M Av Av	DS D DS DS SF SF D DS DS Av	DS DS SF	P P DS Av Range, std. devn. R D P P DS Binomial distribution.
Nuffield Chemistry	DS DS	DS	SF A DS	DS DS	DS DS DS Av
Nuffield Physics	SF SF A A Av D P Av		A Av	A A A A A A A SF SF SF SF P (random walk) Av (R.M.S. Value)	A SF SF Av P SF
SMP O-level mathematics	A (bread and butter arithmetic)	Estimation and Accuracy (A) DS D Av Large and small numbers: SF	P DS D Av Cumulative frequency.	Thinking statistically; Av P D Limits of accuracy; P (tree diagrams)	SF DS significance; Review, summary, and occasional extension of previous work.

KEY
- A approximate calculation
- Av averages
- D distributions
- DS descriptive statistics
- M measurement
- P probability
- SF standard form (also known as scientific notation)

TABLE 2 GEOMETRY AND TRIGONOMETRY - SOME ASPECTS USED IN SCIENCE

Year of Secondary School Course	Year 1 (11-12 years)	Year 2 (12-13 years)	Year 3 (13-14 years)	Year 4 (14-15 years)	Year 5 (15-16 years)
Nuffield Biology	(areas of similar figures)		Parallelogram area b x h	Topology; feed-back loops and control systems (implicit)	
Nuffield Chemistry	Electrical circuit diagrams		Tessellations in 2- and 3-D (close-packing of spheres).		
Nuffield Physics	Regular solids; 3-D arrays; angle, plane, face; volume of cuboid; sphere.	Intuitive ideas of geometrical transformations of a square; angle; rotation; circuit diagrams.	Waves; reflection, symmetry; equal angles; circles, parabolas, ellipses; (enlargement similar triangles) properties of circle; reflection; symmetry; angles; parallel lines; $\frac{\sin i}{\sin r}$	Area of triangle; vectors (momentum).	Motion in an orbit; ellipses; crossed chords method of showing centripetal force is mv^2/r; similar triangles; waves; sine, cosine; vectors (velocities).
SMP 'O' level mathematics	Angle, polygons, and polyhedra; area and area measurement; symmetry; parallelograms and triangles.	Topology; reflections and rotations; translations and vectors; volume (including calculation of volumes); filling space with polyhedra; trigonometry; sine and cosine; Pythagoras' Theorem.	Transformations including reflection; the circle; π; circumference and area; cylinders; 3D geometry: points, lines, planes, and angles; waves, sine and cosine functions; areas of parallelogram and triangle	Trigonometry; tangents and gradients; relation between sin, cos, and tan; parabola; hyperbola; ellipse; co-ordinates and vectors in 3-D; vector geometry.	Vectors and trigonometry; displacement and velocity vectors; Sphere: volume and surface area. Review, summary and occasional extension of previous work.

20. GHANA

Dr J A G McClelland, formerly of the University of Ghana, was enabled to continue his assistance to the development of the Project for Science Integration (PSI) by visiting Ghana as a British Council specialist tourist in July 1973. His specific involvement on this occasion was in the re-writing of the materials for the first year of the secondary school of PSI and an analysis of the phase 1 trials of this project. PSI is organised by the Ghana Association of Science Teachers (GAST). Revision of the year 1 materials was based on feedback reports and as a result an enlarged and improved Teachers' Guide has been produced. The basic development and duties of PSI are carried out by serving teachers and a full description of the project has recently been produced by GAST entitled 'Project for Science Integration'. It is intended that over the next few years this project will make a major contribution to the development of science teaching in Ghana.

Further information on PSI can be obtained from the General Secretary, Ghana Association of Science Teachers, Ministry of Education, PO Box M.45, Accra, Ghana.

21. HONG KONG

Science Teachers' Journal (See SEN 16.21)

This publication is the Journal of the Hong Kong Science Teachers' Association. The Association publishes a bulletin three times a year and the Journal was launched in 1969. The latest edition (Vol 1, No 3, July 1973) contains an interesting Editorial which describes the plans to introduce a pilot project adaptation of the Scottish Integrated Science course. The Editorial draws attention to the need for curriculum renewal and emphasises the concurrent needs for local adaptation of materials and for a programme of widespread teacher retraining. The Editors go on to suggest that thought should be given now to the planning of science courses after the end of three years of integrated science. Attention is drawn to the Schools Council Integrated Science Project and the Editors suggest that consideration be given to a similar course which would give a double subject pass on papers set to cover all three subject divisions.

The Journal contains a number of useful articles including 'Designing Laboratories for Junior Secondary Science', 'Laboratory Safety' and 'Recommendations on Science Teaching at Junior Secondary Level'. In addition there are Equipment Notes and Visual-Aid and Book Reviews.

The Journal is a clear reflection of an active and influential Science Teachers' Association. Further information can be obtained from the Honorary Editor, Mr R T Allsop, Department of Education, University of Hong Kong.

22. IRAN

As a continuation of previous assistance to in-service teacher education in Iran Mr D W Scott of the Science Teaching Centre, School of Education at the University of Bristol, visited Iran under British Council auspices in June/July 1973 to assist with the seminars in the guidance and counselling phase in-service training programme at Tabriz. This is the fourth year in which some assistance to the development of science and mathematics education at these particular stages in Iran has been provided under British Council specialist tours auspices. The seminars this year concentrated on the practical approach to modern science teaching and, in Mr Scott's case, physics teaching in particular. Problem solving played a major role in the work of the seminars. Additional support to the development of modern science teaching in Iran has been provided by a team of up to four science advisers based at the University of Tehran and the Ministry of Education under Overseas Development Administration auspices since 1969.

23. LEBANON

Dr Wynne Evans of the Department of Physics at the University of Liverpool visited Lebanon under British Council auspices in August 1973 at the invitation of the Arab University of Beirut. The purpose of Dr Evans' visit was to act as a consultant on the design and equipping of the new science laboratories and in particular physics laboratories of the Arab University of Beirut. In addition discussions were held on the design of physics courses for physicists, statisticians and mathematicians in the Faculty of Basic Sciences of the Arab University. It is hoped that much of the course will be suitable for intending engineers of the Faculty of Electrical Engineering (Light Current) as well. Dr Evans spent two weeks in Lebanon studying the situation and holding detailed discussions with the Arab University. As a result of these,detailed proposals for development have been submitted to the University authorities.

24. NETHERLANDS

New Trends in the Teaching of the Physical and Integrated Sciences - British Council Course: 12 - 18 August 1973 (see SEN 22.19)

In response to a request to provide an opportunity for members of the Netherlands Science Teachers Association (VELINES) to learn something of British developments in the Physical and Integrated Sciences at first hand, a one week course was run at Goldsmiths' College from 12 - 18 August. The numbers attending the course were limited to 130, consisting of physics and chemistry teachers only.

The content of the course was designed to provide as detailed an account as possible of the various projects currently in operation in Britain in the field of the physical and integrated sciences, as seen against the structure of the British educational system. In addition to the various Nuffield sponsored and Scottish Education Department sponsored projects and courses, sessions on the British Educational System and the 5/13 Project were also included. Each project was introduced by someone who was currently, or who had recently been, associated with the specific project development, and each session was accompanied by various audio-visual and demonstration materials. In addition a practising project teacher was present to lend first hand experience and comment to each session.

Interspersed in the programme were visits to the Science Museum, the Schools Council, and the Royal Institution. A full afternoon was set aside for the exhibition of school science equipment and school science textbooks, as well as a display by the ASE, and films demonstrating many of the projects in action in the classroom.

Great interest was shown by the Dutch teachers in all the projects, but questionnaires indicate that the teachers found most interest and relevance in the Nuffield O- and A-level physics and chemistry courses and in all the Scottish courses and the 5/13 Project. As a result of the interest generated at the Course, and the useful contacts made, plans are now well in train for British Council sponsored visits to be made by Dutch teachers to British schools and vice versa, and for Dutch teachers to be attached to at least two British universities to follow up particular projects or specific fields of research.

25. ZAMBIA

During August 1973 Mr J C Matthews of the University of Lancaster visited Zambia as a British Council specialist tourist. During his visit he was able to study the current position in respect of science examinations for the Cambridge

Overseas Schools Certificate in Zambia and to make recommendations which could lead to improvement in performance. In addition he participated in the annual conference of the Zambian Association for Science Education (ZASE). He conducted workshops for the training of teachers in the design of modern science examinations.

During his visit he was able to visit schools, teacher-training colleges, the Curriculum Development Centre and to make personal contact with the Ministry of Education and the Department of Education at the University of Zambia, as well as ZASE and the JETS organisation of out of school junior engineering technical societies. He also addressed the Regional Headmasters Conference at Ndola.

26. International Perspectives of Design Education

A Conference on International Perspectives of Design Education was held at the University of Keele 8 - 14 July 1973. The Conference offered a unique opportunity to compare the principles of operations and achievements in this field in several countries. The main emphasis was on activities depending largely on the use of materials in school workshops and studios but related to the educational needs of students aged 9 - 18 years. The principal addresses given were as follows:

An International Perspective of Design Education
S J Eggleston.

The American Industrial Arts Situation
J R Lindbeck.

Contemporary Interpretations of Sloyd in Swedish Schools and Colleges
T Lundberg.

The Implications of Design and Craft in English Middle Schools
G Wilson.

Factors Shaping Emerging Trends in Canadian Design Education
P J Briggs.

Industrial Arts, Industrial Design and Design Education
J Saint.

Aspects of Design Education in English Schools and Colleges
M J Laxton.

Technological Interpretations of Design Education in Britain
G B Harrison.

A report of this Conference is now available entitled 'International Perspectives of Design Education', price £1.50, from Studies in Education, Nafferton, Driffield, Yorks YO25 OJL. The Conference in part stemmed from the fact that since 1968 the University of Keele has been the Centre for the Schools Council Project in Design and Craft Education. (See SEN 20.16)

27. International Seminar on Mathematical Applications at School Level

This Conference was organised by the International Committee on Mathematical Instruction (ICMI) and concerned itself with modern mathematical applications. The 180 participants were almost entirely from the Continent of Europe with Belgium, France, Germany, Holland and of course Luxembourg, since the Conference was held at Echternach, all being well represented. The British delegation of 12 participants was led by Sir James Lighthill.

In his welcoming address Monsieur Lucien Kieffer of Luxembourg hoped that the Conference would result in a marriage between traditional Anglo-Saxon pragmatism and Continental purity. The difference of approach however between the two sides on the place of applied mathematics in the curriculum was frequently apparent. In the French-speaking countries particularly, mathematical applications tend to be seen as the optional icing on the pure mathematics cake, while in Britain the experience of applying mathematics is believed to be fundamental to any school course.

There was much emphasis in the programme on recent fields of application including metric spaces, probability, computer science and information theory. A fascinating lecture by Trevor Fletcher on number theory with delightful

applications to architecture and high-speed photography was particularly well received. One marked feature of the Conference was a continued search for relevance in mathematics education and a serse that the introduction of modern mathematics had not proved the universal panacea that was hoped.

28. International Seminar on School-Based Curriculum Development OECD/CERI 1973

In July 1973 the Centre for Educational Research and Innovation of the Organisation for Economic Cooperation and Development (OECD) in conjunction with the Northern Ireland Ministry of Education and the New University of Ulster held an International Seminar on the concept of school-based curriculum development at the New University of Ulster. The joint chairmen of the Conference were Mr J Doolan, Staff Inspector In-Service Training and Curriculum Reform, Northern Ireland Ministry of Education, Professor M Skilbeck, Director of the Education Centre the New University of Ulster, and Mr D Thomas OECD/CERI.

As the various facets of curriculum development have gathered momentum in the last two decades the role of the school and the teacher in particular have come increasingly under examination. However, no previous international gathering of this kind has really examined the concept of school-based curriculum development in depth in this way.

The Conference was divided into two parts. The first week was taken up with a series of presentations on a range of themes related to the overall concept. These covered:

The concept of school-based curriculum development

Aspects of school-based curriculum development in developing countries

The management of curriculum development

Mathematics for the Majority Continuation Project

An example of teacher-based curriculum development

Evaluating school-based curriculum development

The new head in the secondary school context

The director of studies as promoter and coordinator of change

The sixth schools project - Northern Ireland

A Swedish approach to decentralised curriculum innovation.

In parallel with this a series of working groups discussed the papers and the essential points arising from them. During the second week a new series of working groups was constituted to discuss in greater depth some of the practical aspects arising out of the concept; these included study of the dynamics of school-based curriculum innovation from various points of view and support systems for school-based curriculum development.

A report of the Seminar will be published in due course by OECD/CERI, 2 rue Andre Pascal, Paris XVI^{e}, France.

29. Second International Conference on Computer Education 1975

The first International Conference 'Computer Education' organised by IFIP (International Federation of Information Processing Societies) in Amsterdam in August 1970 was attended by 850 participants from 42 countries.

Having regard to the further development and new problems which have emerged in this field, IFIP is organising, in cooperation with IBI-ICC (Intergovernmental

Bureau of Informatics - International Computing Center) and ICMI (International Commission for Mathematical Instruction) and with the backing of the Délégation à l'Informatique, the second International Conference 'Computer Education' in Marseille (France) from 1 - 5 September 1975.

Under the Patronage of the Minister of National Education, this bilingual (English-French) Conference seeks to establish an efficient dialogue between teachers of all disciplines and informaticians.

In its 'Final Recommendations', the earlier Conference concluded the necessity of distinguishing between the methodology of informatics and the computers, and insisted on the considerable advantages to be had by introducing the methodology of informatics into the teaching of all disciplines.

To consolidate the progress made to date in this direction, and in an attempt to gain new insights for the future, a significant part of the Conference programme will be devoted to the problems posed by the introduction of informatics into the teaching of different disciplines.

The provisional programme includes the following points:

a. The contribution of informatics to pedagogy.

b. The influence of informatics on the content and methods of teaching for all disciplines in primary, secondary and university education.

c. The evaluation of the role of computers in teaching (hardware, software and specific languages).

d. The training in informatics of teachers of all disclipines.

e. Training in the various branches of informatics.

f. The use of informatics in continuous training programmes.

g. The contribution of informatics to teaching in developing countries.

The Conference will include, as well as the presentation by their authors of papers accepted by the Programme Committee and round table discussions on the main themes of the programme, a certain number of invited papers presented by experts of international reputation.

The Conference will close with the voting of 'Final Recommendations' emerging from the debates and discussions.

For all information (programme, enrolment, papers, accommodation, etc) write to: AFCET - Service des Congrès, Immeuble centre Dauphine, Avenue de Pologne, 75775 Paris, France.

Some copies of the Proceedings of the first International Conference 'Computer Education' are still available. Contact AFCET.